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ARCHIVES OF OPHTHALMOLOGY.

OCULAR MANIFESTATIONS FOLLOWING EXPOSURE TO VARIOUS TYPES OF POISONOUS GASES.[1]

BY GEORGE S. DERBY, M.D., BOSTON.

(With four illustrations in color on Text-Plate X.)

IN 1915, the Germans began to use gas for the purpose of disabling their opponents. This was first used in the form of drift or cloud gas. Among the varieties sent over was the so-called lacrimatory gas, which was used for the purpose of temporary disablement. Lacrimatory gas caused intense burning pain, profuse lacrimation, and injection of the conjunctiva. The men who had been gassed showed marked photophobia and watering, the palpebral borders were swollen and showed erythematous lesions, which followed rubbing with the hand and the handkerchief. There was marked conjunctival injection and occasional chemosis. According to Gremeaux (1), the cornea presented in its peripheral portion a fine exfoliation of the epithelial covering. The milder cases recovered very quickly. The corneal lesions showed no tendency to extend. The more severe cases were usually well within two weeks, or then only showed a slight photophobia and watering, which disappeared at the end of three weeks or a month. The reaction was always more severe when a bandage had been used on the eye.

Much more serious were the injuries produced by mustard

[1] Read at meeting of American Ophthalmological Society, Atlantic City, June, 1919.

gas (dichlorethylsulphide). This gas was first made by Victor Meyer in 1886. He described it as a heavy, oily fluid, sinking in water, and not miscible with it, of neutral reaction, having a faint sweetish ethereal odor slightly suggestive of the sulphur compounds, with a boiling point of 217° C. One of his laboratory workers engaged in making it developed skin eruptions with a transitory conjunctivitis. Meyer himself was not affected by it, and therefore concluded that individual susceptibilities vary greatly. He also concluded that injection of this compound could produce metastatic lesions.

Mustard gas was sent over in shells, the so-called yellow cross-shells. It was first used extensively at Ypres on July 12–13, 1917. Mustard gas causes sneezing, followed by increasing nose and throat irritation. There is painful irritation of the eyes and sometimes vomiting. The action is a delayed one, and takes place in from two to six hours, with increasing inflammation of the mucous membrane and the skin. Severe erythema of the skin develops, followed by blistering. The moist portions of the body are more severely affected. Respiratory symptoms develop, and in severe cases bronchitis and secondary pneumonia may be seen in thirty-six to forty-eight hours. Pneumonia is the most frequent cause of death.

All grades of mustard gas involvement of the eyes may be met with. They may be divided into slight, moderate, and severe. The slight cases form 75% or 80% of those affected. Often, in the mild cases the subjective symptoms are severe. The lids are held tightly closed. There is profuse lacrimation and a considerable degree of injection of the conjunctiva.

In those more severely affected, the lids always show a considerable amount of redness and swelling and often the formation of numerous bullæ. The lid margins are sometimes excoriated. The lids are held closely pressed together, and any attempt to separate them is accompanied by severe pain, so that often it is necessary to use one or two drops of cocaine and employ a lid elevator in order to get a good view of the conjunctiva and cornea. The conjunctiva is markedly injected throughout, and may show a considerable degree of chemosis, which is most marked in the upper and lower conjunctival folds, which may project beyond the lids. Often the injection is of the distinct ciliary type. The region of the palpe-

Drawing of the cornea in the acute stage of severe burning.

Drawing of cornea in the stage of resolution after severe burning.

bral fissure is the most severely affected. In severely burned cases there is often an area of solid white œdema of the conjunctiva in the palpebral fissure, which presents a very striking appearance.

The corneal lesions are also of varying severity. In the milder cases there is only a very slight roughening of the corneal epithelium, which may or may not stain with fluorescein. In the moderately severe cases, there is a marked roughening of the epithelium with irregular grayish areas of opacity scattered throughout the cornea. Our British colleagues liken the appearance of the cornea in these cases to that of an orange skin. The area of the palpebral fissure always shows the most marked changes.

In the most severe cases a very saturated gray band is seen traversing the cornea in the area of the palpebral fissure, and this band is sometimes of almost porcelain whiteness. The roughening of the cornea is due to œdema of the epithelium and later on to exfoliation. Where corneal involvement is marked, fluorescein staining takes place.

Secondary conjunctivitis, especially when the eyes have been bandaged, is prone to develop; and secondary infection of the cornea may take place and may result in ulceration, and later even panophthalmitis and a loss of the eye. Luckily, such cases are comparatively rare.

The British Consultants have observed only about ten cases of corneal ulceration where impairment of vision was left behind. In four cases, panophthalmitis developed and the eye was eventually removed. Among 1500 cases, Teulières (2) saw one case of panophthalmitis and three cases of ulceration of the cornea. During the eighteen months preceding the armistice, about ten cases of corneal ulceration came under my observation—two of these were seen while serving with the British, but none of these were under my actual care, although many hundreds of gassed men passed through the hands of the hospital unit I was serving with at that time. A number of damaged eyes were seen while serving with the American Expeditionary Forces. One unfortunate was well on the road to losing both his eyes, largely, I believe, due to bandaging and to the lack of proper care. One case was seen where apparently no secondary infection of any severity had taken place,

and yet, marked opacity of the cornea was present after many weeks which promised to be permanent. I call to mind another case where, after the process had almost entirely resolved and the cornea was bright and clear, a secondary ulceration developed of a severe nature, apparently due to a lowered vitality of the tissue. Ring abscess of the cornea has been noted by several British observers.

The lesions of mustard gas are in the nature of a chemical burn of the tissues of the eye. Warthin likens it more especially to the effect produced by hydrochloric acid. Pissarello (3) has exceptionally seen cicatricial ectropion following burns from mustard gas. Lister says that occasionally the actual liquid from the yellow cross-shell passes into the eye. The lesion then is similar to that produced by burns from other liquid caustics, and necrosis, ulceration of opposed surfaces, and symblepharon may occur. Personally, I have not seen such cases.

Teulières and Valois (4) describe slight iritis, cloudiness of the papilla, slaty tint of the retina, and congestion of the retinal veins. They describe this as a benign neuroretinitis. One may see a questionable hyperemia of the disk and retina, but it is altogether unlikely that disease of the posterior half of the eyeball following exposure to mustard gas occurs.

Cèrise, in his report to the French Ophthalmological Society in March, 1918, divides the cases into three groups:

1. Benign, representing ten to fifteen per cent. of cases. Duration ten to fifteen days.

2. Medium, about 80% of cases. Duration five to six weeks.

3. Severe, three to five per cent. of cases; with marked general symptoms, often developing a broncho-pneumonia.

In our experience and in that of our British colleagues, the mild cases form a much larger percentage. In the first place, there are a very large number of mild cases of gassing which are never sent back to the hospital.

In the mild cases which reach the hospitals, recovery is rapid, and they may usually be sent back to duty in from one to two weeks. The moderately severe cases may have a duration of four weeks to two months and even longer. The conjunctival chemosis subsides fairly quickly. The white

Severely burned eye in the acute stage.

Slightly later stage of acute burning.

areas of œdema often take one to two weeks to disappear, and are replaced by an intensely red area. Colonel Lister calls attention to a peculiar mauve tint seen in these cases similar to that seen in certain cases of episcleritis. It may be two to four months before the most severe cases may be returned to duty.

Patients subject to chronic conjunctivitis and blepharitis often have their old condition lighted up by gas, and are then very resistant to treatment. Certain individuals develop a neurotic condition following exposure to gas. It is characterized by lacrimation and photophobia. This is probably due, at least in part, to the strong nervous impression produced upon the man by the severe irritation of the eye which the gas causes. He fears that he is about to become blind. Moreover, his general condition has often been impaired. Unless he is properly handled at this time, his convalescence is apt to be much prolonged, and certain of these men develop into malingerers.

TREATMENT.

The gas mask when worn protects the wearer against the effects of mustard gas in the eyes and also in the respiratory passages. Naturally, it does not protect against skin lesions. When the soldier receives his first bathing after exposure to mustard gas, the eyes should be thoroughly washed out. As good a solution as any is sodium bicarbonate, and this was used as a routine in our gas hospitals, of which we had several in the areas back of the Argonne. In the later stages, when the soldier is sent back to the Evacuation or the Base Hospital, frequent bathing should be given with a lukewarm solution either of boric acid, salt solution or 1% sodium bicarbonate. Following this, a drop of oil should be instilled into the eye. The oil which we found the least irritating was liquid albolene. Theoretically, a vegetable oil, such as castor oil, should prove to be of value, as it dissolves the mustard gas. In practice, however, we found it rather more irritating than the liquid albolene and gave it up. For the milder cases, this treatment will suffice.

When, however, there is much blepharospasm and irritation, atropine should be always used, for this indicates a greater or

less involvement of the cornea. If a one per cent. solution of atropine is used once or twice a day, it will usually keep the pupil well dilated. Occasionally, however, one must use it in larger amounts. A shade should always be supplied or a pair of dark glasses. The eyes should never be bandaged. Agreement on this point is unanimous. In the British Service and in our own, a great deal of trouble was experienced from the bandaging of these cases. In a number of cases where secondary infection of the cornea took place and the vision was permanently impaired, or the eye was even lost, we felt very strongly that bandaging contributed materially, if not entirely, to the bad results. Our experience is borne out by Warthin's experiments.

In those cases where secondary infection of the conjunctival sac took place, a weak antiseptic solution was found to be of benefit. Most often we used argyrol or protargol. If an actual septic ulcer of the cornea developed, it was treated by the methods used in civil life. As the nutrition of the cornea is impaired, it is well to apply heat when corneal ulceration occurs. The ulcer may be lightly touched with pure carbolic acid, and if necessary a Sæmisch section may be made.

Atropine should be continued so long as any corneal involvement in gas cases continues, and a shade or dark glasses should be worn as long as the pupil is dilated. As soon, however, as the pupil has resumed its normal size and the injection has largely disappeared, the patient, if his general condition permits, should be gotten out of his bed and should be sent outdoors into the light, and stimulating treatment should be applied if subjective photophobia and lacrimation still persist. Cold bathing of the eyes seems to be of value and a weak solution of sulphate of zinc twice a day. It is always wise to give the patient in this stage some sort of light duty. One should be always on the watch to combat the beginning of a neurasthenic tendency. These patients always recover with normal vision, unless a severe involvement of the cornea has taken place. In the treatment of gassed eyes cocaine should not be used, as it tends to damage further the corneal epithelium.

Reference has been made to a large series of cases seen while serving with the British Expeditionary Forces in which, to our knowledge, no permanent damage of the eyes took place.

Stage of resolution after severe burning.

Late stage of resolution.

This may be laid to several factors. In the first place, we got our cases early, being little over fifty miles from the front, and British transportation after three years of war had become wonderfully organized. Secondly, the eyes received immediate attention on reaching us, and treatment was faithfully carried out by an exceptionally strong and experienced nursing staff. The natural deduction is, and in this our British colleagues agree, that with proper handling of cases mustard gas should very rarely cause permanent visual damage. The majority of gassed cases tend toward spontaneous early and complete recovery. Visual damage is seldom seen, and complete blindness must be one of the very rare results of the war.

PATHOLOGY.

In the American Expeditionary Forces up to the time of the armistice, we had no provision for the pathological examination of eyes, though this was planned and would have been instituted had the war gone on. The British were more fortunate, for, although they did not succeed in obtaining material from those cases that died in the first few days after being severely gassed, they succeeded in obtaining eyes gassed a fortnight or so before; and I may be permitted, therefore, to quote from one of Colonel Lister's reports:

"The pathological examination of eyes which have been gassed show changes in the corneal epithelium, the substantia propria, and in the conjunctiva. Sections of the cornea show definite changes in the epithelial layer. The deeper cells, instead of being columnar, are flattened. The thickness of the whole layer is diminished, so in passing from the periphery toward the center of the cornea it gradually thins down till only a single layer of flattened cells is left, while in parts this also is lost and Bowman's membrane is left bare. The substantia propria in some cases shows infiltration of round cells between the layers, as is found in other cases of deep inflammation. In the conjunctiva over the sclerotic, granular masses have been seen in the subepithelial tissue, which probably correspond with the solid white exudate seen in the interpalpebral aperture."

At the close of hostilities, the American Expeditionary

Forces were fairly well equipped to care for gassed eyes. The medical officers at the various gas hospitals were sufficiently acquainted with the lesions which could occur to be able to give those cases proper treatment. At most of the mobile and evacuation hospitals, there was a trained ophthalmologist who had either had some personal experience in the treatment of gas, or who had been instructed in that work by personal visits from the consultants and by means of circulars which were sent around from time to time. The same also applied to practically all of our base hospitals in France. Bandaging of the eyes was strenuously combated. Medical officers and the medical personnel on hospital trains should also be instructed in this work.

When gassed cases are evacuated at base hospitals to convalescent camps, it is important that they should be grouped at places under trained medical supervision, in order that those cases with irritable conjunctivæ should be brought into condition to be sent back to duty at the earliest possible moment. Some of these cases may be held almost for a month under supervision, when with proper treatment they could be sent back to duty in a comparatively short time.

EXPERIMENTAL WORK ON MUSTARD GAS.

In this country recently a series of very important observations on the effects of mustard gas on the eyes of animals have been made by Warthin and various others. In these experiments, mustard gas was applied directly to the center of the cornea with a fine pipette and in uniform minute droplets. In another series, animals were exposed to the vapor of mustard gas in varying concentrations and time. These experiments were carried out mostly on dogs and rabbits.

Exposure of fifteen minutes to a concentration of 1:20,000 was found to cause a burn of the same severity as from a standard droplet applied to the center of the cornea. Fifteen minutes after the mustard gas was applied, congestion of the superior palpebral conjunctiva was noted. In one hour the conjunctiva had become œdematous. From then on, there was progressive increase in the œdema until there was a ring of swollen conjunctiva about the cornea.

ILLUSTRATING DR. DERBY'S ARTICLE ON "OCULAR MANIFESTATIONS FOLLOWING EXPOSURE TO VARIOUS TYPES OF POISONOUS GASES."

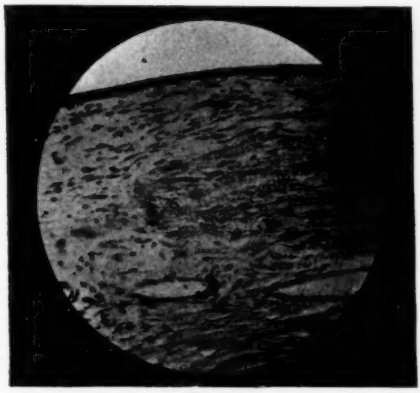

FIG. 1.
Granular exudate beneath bulbar conjunctiva, probably corresponding to solid white exudate.

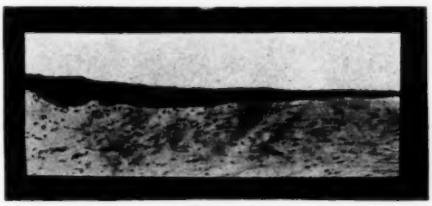

FIG. 2.
Corneal epithelium diminished in thickness. Cells are contracted and stain deeply.

FIG. 3.
Thinning of corneal epithelium. Bowman's membrane laid bare, cellular exudate in the substantia propria.

Sections of Gassed Eyes Kindly Loaned by
COL. W. T. LISTER, R. A. M. C.

Corneal changes took place in five to six hours. They consisted first in faint clouding, roughening, and irregularity. There was an increasing seropurulent exudate. Photophobia and lacrimation were marked.

In eight hours, the cornea became porcelain white and there were irregular rounded areas without epithelium. Minute subconjunctival hemorrhages were seen. By the second day, the œdema was marked. The denuded area of the cornea increased in size, and there was a large opacity in the lower half of the cornea, which often showed an opaque band running horizontally. The lids were sealed by secretion. Hypopyon was sometimes seen.

During the second week, the exudate decreased somewhat, but the corneal opacity remained unchanged. The lids, however, became unsealed.

During the third week, the lesions were slowly progressive, but a sluggish reparative process began. Ectropion of the lower lid was noted.

In the artificially produced burns from mustard gas, Warthin found that the changes varied enormously according as to whether the conditions were treated or left untreated. If no treatment were given, the lids sealed and exudate accumulated. Purulent panophthalmitis often developed within three weeks, and within six weeks the eyes may be destroyed. If a larger dosage is used and the eyes remain untreated, panophthalmitis may develop more quickly. Panophthalmitis was due entirely to secondary infection, which occurred after several weeks in untreated cases even after slight gassing, and much more rapidly after heavier doses. Warthin found that staining with fluorescein took place very early after the application of mustard gas to the cornea. These observations show conclusively the damage which may be done by the bandaging of the eye.

A large number of eyes were examined microscopically. The earliest changes noted in the cornea consisted of pyknosis, contraction of the epithelium and of the substantia propria, most marked at the corneal vertex extending down to Descemet's membrane. This is followed by a loss of nuclei until by the twelfth hour the corneal vertex shows complete necrosis, the necrosis often extending from the limbus nearly to the

scleral junction. Desquamation of the dead corneal epithelium begins in about five hours. Polynuclear infiltration of the sclerocorneal junction begins in five to six hours. The earliest signs of regeneration of the substantia propria of the cornea were noted at the end of sixty-five hours. The new formation of blood-vessels into the limbus was well marked at the seventh day. Slow repair of the cornea continued for several weeks with development of a highly vascularized corneal cicatrix. Marked changes in the corneal thickness occur as the result of separation of the lamellæ, œdema, cellular infiltration, and fibroblastic proliferation. The severity of the corneal lesion is in direct proportion to the concentration of the gas and the period of exposure. The necrosis of the conjunctiva is less in degree than that of the cornea or the skin surfaces of the eyelids. The primary necrosis rarely extends beneath the basement membrane of the palpebral and bulbar conjunctiva, except at the palpebral margin. There were shallow ulcers at the palpebral margin. There was extreme œdema of the subconjunctival connective tissue, most marked in the bulbar conjunctiva near the scleral sulcus and in the palpebral conjunctiva of the upper lid. Petechial hemorrhages were of frequent occurrence in the subconjunctival connective tissue. Regeneration of the conjunctiva takes place rapidly and is followed by permanent thickening. Iritis and iridocyclitis are common occurrences at about the third to sixth week in the uncared-for cases as the result of secondary infection. In the cared-for cases, no changes were observed in the iris, ciliary body, choroid, retina, and optic nerve except congestion and œdema. There was increased functional activity of the lacrimal gland, with subsequent overuse atrophy and subsesequent hypertrophy. Warthin regards the relatively slight penetration into the subconjunctival tissues as due to the protection afforded by the moistness of the surface and lacrimation.

For treatment Warthin recommends a one half of one per cent. solution of dichloramin-T in chlorcosane. His experiments show that this solution if applied to the eye before exposure has a definite prophylactic action, and when applied to the eyes before and after exposure the resulting lesions are much less severe. Its use is indicated after exposure to gas

for its germicidal action and the prevention of secondary infection.

Warthin concludes that the action of mustard gas on the conjunctiva is essentially the same as that on the skin. The conjunctiva is less susceptible to its action. Even in the milder cases of conjunctivitis, localized roughness or irregularity in the conjunctival surface may persist for weeks as the result of localized œdema, hyperæmia, and cellular infiltration.

As was mentioned before, Victor Meyer stated that he had produced a metastatic conjunctivitis from the injection of mustard gas. This statement was confirmed by Haldane. In an attempt to verify these statements, Warthin experimented on eight animals. In none of them did conjunctivitis develop.

Great difference in individual susceptibility has been found by a number of observers. It was tested by Marshall, Lynch, Smith, and Williams, of the Medical Division of the Chemical Warfare Service. They found a decided individual difference in the skin reaction to mustard gas independent of changes in sensitivity due to sweating. About 20 to 40% of the white men tested showed a certain degree of resistance; while 78% of negroes tested showed a similar resistance. About 2% of white individuals showed a hypersensitivity; no hypersensitive cases were found among negroes. Individual differences in sensitivity were also noted in animals. It is not improbable that the hypersensitivity to mustard gas may occur in those cases which show the picture of a persistent thymus and characteristic lymphoid hyperplasia.

My thanks are due to Col. W. T. Lister, C. M. G., Ophthalmic Consultant B. E. F., for very kindly sending me his "Report on the Effects on the Eyes of Irritant Gases Used in Warfare," also for the Atlas on Gas Poisoning prepared by the Medical Research Committee, and for various histological specimens of gassed eyes.

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A NEW OPERATION FOR GLAUCOMA INVOLVING A NEW PRINCIPLE IN THE ÆTIOLOGY AND TREATMENT OF CHRONIC PRIMARY GLAUCOMA.

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(With one illustration on Text-Plate XI. and seven illustrations in the text.)

IN this report of a new operation for glaucoma, it is well to review briefly the principles on which all former operations for the relief of this condition are based, in order to better appreciate the new principle on which this one depends, and to recount the observations and experiment which led to its adoption.

All former operations have had the object in view of one or several of the following:

(*A*) Drainage through the canal of Schlemm by exposing a large area by iridectomy well out to the attachment of the iris, or in the theory that the cut edge of the iris allows the aqueous to filter into it and thereby come into closer contact with the capillaries and be taken up by the blood stream, thus relieving the canal of Schlemm.

In the attempt to explain the undoubted benefit which iridectomy without a filtering scar sometimes gives, these two principles are the only ones worthy of notice advanced up to the present time. I shall endeavor to prove later that they are not the chief ways in which iridectomy gives relief.

(*B*) The failure of many iridectomies led some surgeons to seek purposely drainage through the sclera into the subconjunctival spaces, either (1), through iridectomy with filtering

scar; (2) sclerotomy, or (3) both combined, or (4) with seton, by (5) sclerectomy alone or combined with iridectomy, buttonhole or complete, and (6) by including the iris in the wound (iridotasis). It is unnecessary to enumerate the various operations which have the principle of drainage through the sclera in view.

(*C*) Drainage into the subchoroidal spaces posteriorly by puncture of the sclera in the ciliary region, or by freeing the ciliary body to connect the anterior chamber with the subchoroidal spaces by breaking through the pectinate ligaments as in Furgus's operation. Both of these operations relieve the intraocular pressure, but result is not permanent.

It is unnecessary for one to point out that each and all of these procedures are attended with grave dangers, nor are they, even when successfully performed, the proper ones to select in most cases. No one is justified in taking a greater risk when a lesser one may be successful, especially if it will not add to the danger of relieving the pressure with the greater risk later in case of failure.

My operation differs from all others in the fact that it is an attempt to drain from the posterior chamber into the anterior chamber. It is not only a difference in procedure, but a difference in principle, and therefore, if successful, a distinct advance in our knowledge and treatment of chronic primary glaucoma.

Normally the aqueous passes through the pupil from the posterior to the anterior chamber, but it is here contended that in glaucoma this passage is impeded on account of the iris hugging the lens over too great a surface extent. Some of the aqueous gets through while some passes back, forcing the lens and the iris still more forward.

For the past three years I have been advocating in class and elsewhere, that the operation that counted most was that which gave drainage from the posterior to the anterior chamber. Some time ago I established the fact that if this could be obtained the canal of Schlemm could, in most cases, take care of the fluid which got into the anterior chamber. I have succeeded in doing this in several ways and with good results. I shall here give a brief report of some of the observations which led to that conclusion:

1. Three years ago I saw a case of glaucoma which was operated on forty years ago by iridectomy in both eyes with perfect success, in which there was no filtering scar, and also there was no inclusion of either root of the pillars of the coloboma in the wound. The patient had senile cataract in both eyes. The opacity was central with a few riders from the periphery and a great deal of clear cortex. The outline of the lens could be seen well. There were no adhesions of the iris to the lens; but the iris lay closely on the lens over a great surface extent and only left the lens at the extreme periphery, and it was easily seen that the only way in which the aqueous could pass to the anterior chamber was through the opening made in the iris by the iridectomy. This could happen only at the periphery of the iridectomy. The anterior chamber was a little less than normal. If there had been the slightest adhesion of the root of the pillars of the coloboma in the wound it would prevent the proper opening of the filtering angle and the wonderful success in this case would not have been achieved. There was no intraocular pressure in either eye, and the result of the operation was $\frac{20}{20}$ with corrective glasses. She was operated on for the glaucoma in Springfield, Illinois, and was unable to recall the name of the surgeon. It is sufficient for me to say that I took particular pains to assure myself that his diagnosis had been correct and that it was a case of primary chronic glaucoma.

It is widely held that all the benefit from iridectomy comes from the fact that in these cases there is a filtering scar. I admit that many operations of iridectomy for glaucoma would be failures were it not that fortunately a filtering scar was inadvertently or purposely made. But there was no filtering scar in this case, and it disproves, as do many other cases which I have observed, the necessity of the filtering scar in operative cure of early glaucoma. Other observations were made on successful iridectomies for glaucoma, and where there was no filtering scar they gave drainage into the anterior chamber. Where there was a filtering scar the anterior chamber was less deep and the results were not so good, excepting in old cases in which, no doubt, there were adhesions all around the periphery of the iris shutting off the filtering angle. Of course in such cases filtration through the sclera is necessary and an

iridectomy without it would be useless. If we carefully observe the lens through the peripheral iridectomy in an Elliot operation we find the iris hugging it to almost the extreme periphery. This observation must be made when the anterior chamber fills and has remained normal for several weeks as the lens always comes forward immediately after the operation and remains so for some days or even weeks. It will be seen that at this time the filtering bleb becomes more circumscribed and more localized, so that it would be impossible to demonstrate that there was much if any filtration from the bleb and it partakes of the nature of a small staphyloma, no doubt capable of distending during temporary increase of intraocular pressure. If an examination of the contour of the iris is made in unoperated glaucoma one cannot fail to see that the bulging of the iris is the same as the anterior surface of the lens and this too can be followed far out toward the periphery, excepting in some eyes in which the cornea is very small, and in these it takes but little to impede the flow of the aqueous through the pupil, as in the eyes of negroes. In some cases the movement of the iris to light can be seen to be impeded by the lens, and the amount of surface extent hugging the lens can be determined. The movement of the iris and the apparent bulging of the lens should be weighed carefully and compared with that of normal eyes. In the study of this phase iridectomies done as a preliminary to cataract operations furnish much instruction. Some weeks should elapse after such iridectomy before we can get accurate data because the eye should, as in the cases above mentioned, become normal, especially in regard to the anterior chamber. It will be observed that in these eyes of normal intraocular pressure, the pillars of the coloboma do not rest on the lens, and but barely touch it only near the pupil. Of course, we are not now considering intumescent cataracts. These hug the lens to a greater surface extent than certain types of senile cataracts, and this is why we have a tendency to glaucoma in such cases. All these observations are made on living eyes much better than in pathological specimens, which are always altered in preparation either by shrinkage of the tissues or displacement of the structures, and can be verified from the practice of most ophthalmic surgeons.

In the light of these observations I concluded that most of

the success in iridectomy, iridotasis, and sclerectomies with iridectomy depends on the fact that the drainage into the anterior chamber is often achieved by these operations, though, in such operations as the Elliot, in which there is free drainage into the subconjunctival tissue, the full use of the canal of Schlemm is not made unless the conjunctival bleb recedes or becomes circumscribed by adhesions, and the anterior chamber deepens without too long a delay. It was further concluded that where the filtering angle was closed permanently as it is in some cases in which there are adhesions of the iris, and in others in which there is a lack of proper development of the pectinate ligaments or the canal of Schlemm, it would be useless to drain into the anterior chamber. These classes of cases, however, notwithstanding any prevailing opinion to the contrary, I have found to be very few—much fewer than I had expected. They are amenable only to such operations as the Elliot or other scleral drainage. In September of 1916, I began with great caution to attempt drainage into the anterior chamber. Previously, I had been doing the Elliot operation and had so much success that I was reluctant to give it up even for a method which looked so promising and was much simpler. My first case was one of acute glaucoma. The iris and the lens were almost filling the anterior chamber and much of the periphery was apparently, though not, adherent to the back of the cornea. I made a five-millimeter incision of the cornea and iris together at the periphery, taking care not to injure the lens, with the result of a permanent fall of intraocular pressure, which has persisted ever since, and the patient has $\frac{20}{30}$ vision, which would probably be $\frac{20}{20}$ but for some corneal nebulæ. There were some adhesions of the iris at the pupillary border which I could not demonstrate all round the pupil, and at the same time I thought that there might have been some further back impeding the flow through the pupil, and therefore I had to consider this experiment open to doubt in regard to chronic primary glaucoma, although the other eye had been operated on by iridectomy some years previously with equal success by another surgeon. In this eye there was no filtering scar, and the iridectomy, of course, gave drainage into the anterior chamber. I did not select this case. It was thrust upon me on account of the acute attack, and I had to do it immediately at

the home of the patient without any means of getting instruments to do any other operation. At that time I would not have selected such an operation for this case, though now it would be the first one to be tried. There was so much steaminess of the cornea that no adhesions could be made out until the eye was normal in intraocular pressure and the cornea became clear, but it was evident that they were old adhesions.

Following this I did six selected cases each of which had one eye very far advanced and the other with between $\frac{3}{10}$ and $\frac{3}{20}$ visions. In the very advanced eye I sought to obtain drainage by complete iridectomy, avoiding filtering scar, always leaving an area in which I could do an Elliot operation, should this fail, without the objectionable feature of having to dissect through the sclerotomy scar to split the cornea. In the better eye I made a five- or six-millimeter incision on the scleral side of the cornea-scleral junction, and inserted the iris forceps, drew out the periphery of the iris and cut a small piece off, making a small peripheral iridectomy which always appeared triangular in shape when replaced, as the accompanying picture of the largest peripheral iridectomy of the six will show (Fig. 1). All except two of the complete iridectomies were a perfect success in reducing intraocular pressure to normal. These two reduced it to such extent as to bring vision up, in one case from $\frac{20}{100}$ to $\frac{20}{50}$, and in the other, from hand movements to $\frac{3}{20}$. The hand movements were only in the extreme periphery of the temporal field; at the present time the nasal field, for a ten-millimeter disk of white, extends to thirty degrees, and the tension is 30*mm* of mercury by the Shiotz Gradle. Two months ago I made a small peripheral iridectomy in this eye, which reduces the tension to 23*mm* with a slightly deeper anterior chamber. The peripheral iridectomy in these six cases reduced the intraocular pressure to normal without exception, and the anterior chamber always became, and remained, deeper than in the complete iridectomies. The last of these was done in October, 1918, and the intraocular pressure has remained normal, and the vision undiminished to this time, and there seems no likelihood of a change. It is easy to replace the iris in peripheral iridectomies, and they heal without a filtering scar. They were more successful and better looking than the Elliot operation. They were done on very

ILLUSTRATING DR. CURRAN'S ARTICLE ON "A NEW OPERATION FOR GLAUCOMA INVOLVING A NEW PRINCIPLE IN THE ÆTIOLOGY AND TREATMENT OF CHRONIC PRIMARY GLAUCOMA."

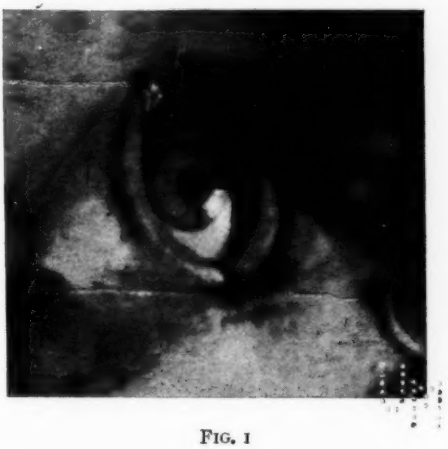

FIG. 1

early selected cases and I had to wait till time told its story. Consequently during these experiments, and for some time afterwards, I still continued to do the Elliot operation on most of my cases. I was not yet sure of my grounds until almost two years had elapsed from my first experiments, which was sufficient time to prove that drainage into the anterior chamber was of permanent benefit.

These operations of peripheral iridectomy were an improvement on any I have known except the recent development to be described in this paper, which I consider the simplest and safest of all operations for early chronic primary glaucoma and for some later stages of this disease.

OBSERVATIONS AND EXPERIMENTS ON A GLAUCOMATOUS RABBIT'S EYE.

Another incident happened which confirmed me in the belief that the chief mechanical cause of chronic primary glaucoma was a lack of proper drainage from the posterior to the anterior chamber. Dr. Major of the Department of Pathology had been experimenting with certain dyes on rabbits, and called my attention to the fact that a rabbit which had a fully developed cataract showed, when injected with eosin, the stain coming through the pupil into the anterior chamber. With the milky background of the cataract this could be seen beautifully. The illustration of the place of formation of the aqueous in the posterior chamber was so convincing that we had the rabbit injected several times for demonstration purposes some weeks apart. As time went on it was found that the stained aqueous would not come through the pupil until we shook the rabbit vigorously. This evidently displaced the lens and the stained aqueous would gush through. About this time the eye became hard, but shaking would reduce the intraocular pressure temporarily after the lapse of from fifteen to twenty minutes. Finally it could not be demonstrated at all, and the injections of eosin were neglected for six or eight weeks, the eye being hard when they were discontinued. After this time had elapsed another injection of eosin was made and it was found that the stained aqueous came through at one side of the lens in two distinct currents, side by side. A close ex-

amination was made and it was found that there were two small furrows in the lens on the anterior surface. The intraocular pressure was tried, and it was normal. Thus nature had reëstablished drainage into the anterior chamber, and the glaucoma was cured. The intraocular pressure had probably been normal from the first appearance of the furrows. Since the rabbit had been neglected for six weeks, one could not tell what time this reduction of intraocular pressure took place. This part of the experiment was done at a meeting of the Kansas City Eye, Ear, Nose, and Throat Club at the University of Kansas Medical School in October, 1918. Some cases cured by drainage into the anterior chamber by peripheral iridectomy were also shown at this meeting. The intraocular pressure of the rabbit's eye remained normal for three months afterwards. There was no iritis at any time in this eye and no adhesions of the iris to the capsule of the lens. It showed clearly that the lens does not have to enlarge much, nor does it have to come far forward in order to impede the aqueous flowing from the posterior to the anterior chamber through the pupil. It also goes to prove that what begins this mechanical condition is either an enlargement or a pushing forward of the lens, and once this is done ever so slightly we have a way in which it can be kept up by the back-wash of the aqueous, which would push the lens more forward. The closing of the filtering angle is a later development secondary to the events above mentioned.

With all this evidence in hand it might be supposed that one would try drainage into the anterior chamber in every case in which there were no absolute contraindications. This was not done for time must elapse before one can be certain of the permanent success of any operation for glaucoma, and during the last two years over one hundred and fifty Elliot operations with peripheral iridectomy were done partly because it was felt that both drainage into the anterior chamber and subconjunctival drainage could be obtained at the same time, making doubly sure of reduction of tension. This was a mistake, for the drainage through the sclera prevented the proper opening of the anterior chamber till later; and if this drainage happened to be too free it completely frustrated the good which should be achieved by the peripheral iridectomy, and

left only the unnatural scleral drainage, which of course saved the eyes from blindness, even if in a crude manner. However, in the majority of cases I was pleased to see the bleb becoming circumscribed by adhesions, and take on the character and appearance of small staphyloma, and the anterior chamber deepen. Because of these observations I consider that this work had its instructive value, which was not lost. In my work with the Elliot operation I found the same great fault, but to a lesser degree, as with the wide iridectomy, the too sudden reduction of intraocular pressure, and the danger of either retinal or expulsion hemorrhages. The peripheral iridectomy above described, with a five-millimeter incision, reduced this danger, but still it was not entirely eliminated. It seemed to me that the smallest kind of a hole in the iris would be sufficient to give the required drainage. To do this without injuring the lens at first seemed a difficult matter. My study of the position of the lens *in vito* enabled me to select the position in the iris in which a puncture would be least likely to cause such an accident. I was fortified by the fact that I had cut through both cornea and iris in the case of acute glaucoma mentioned in the early part of this paper without injury to the lens and with perfect results. Consequently I determined to try simple perforation of the iris at the periphery. In order to find the easiest way in which to do this I selected five rabbits and using a Knapp needle knife tried various ways of making a small hole in the iris. I found this could be readily accomplished and the risk of injuring the lens much less than I had anticipated. I shall now report a series of cases in which this principle was carried out.

CASE I.—In March, 1919, I had a patient in the hospital on whom I had already done an Elliot operation on the right eye, which was almost blind for three years, and I explained to him the nature of the experiment which I wished to perform on his left eye, and he willingly consented to have it done. This man had a vision of $\frac{20}{80}$, and his temporal field was limited to thirty-five degrees. He was under eserine for two years, and it was producing a good deal of conjunctival and even lid irritation. The intraocular pressure under eserine was 35*mm* (McLean tonometer) of mercury most of the time while under this treatment, but, in spite of the fact that there were regular instillations of one drop of ½

of a 1% solution four times a day, there were rises of intraocular pressure, especially in the morning, which probably took place during sleep. The patient was prepared in the usual way with instillations of five per cent. cocaine, and an injection of 1% cocaine with adrenalin was made in the upper part of Tenon's capsule, so as to catch the ciliary nerves coming to the iris in order to render the puncture of the iris painless. A Knapp needle knife was passed edge upward through the cornea-scleral junction on the temporal side of the upper quadrant of the eye. As the point entered the anterior chamber it was directed upward and inward for five or six millimeters through the aqueous, and then depressed to engage the iris, pushing it forward into a small fold which makes the iris more easily punctured, without danger of injury to the lens. When the point was seen to make a counter puncture of the iris the knife was withdrawn, leaving two small black holes in the periphery of the iris, difficult to see with the naked eye. No aqueous was lost. The eye was closed, but no bandage applied, and the patient sent back to his room. Two hours afterwards the eye was harder than when the operation began, and the anterior chamber was deeper. There was no aqueous lost, and the cocaine had probably caused the temporary increase of intraocular pressure before the natural drainage had time to be reëstablished. The following day the tension was normal, and has remained between 32*mm* and 38*mm* (McLean tonometer) ever since, without any other treatment. The vision has increased to $\frac{20}{40}$ and the field is now almost normal. Ten days after the operation, when the wound had healed and the eye was perfectly quiet, it was put under homatropin for one day. The intraocular pressure was taken several times during that day and at nine o'clock next morning. At no time during this test did it rise above 35*mm*. When seen on the 4th of July, 1919, the intraocular pressure was 35*mm*, and on September 6, 1919, it was 38*mm*. It is well known that the intraocular pressure of the eye in glaucomatous patients varies under different degrees of emotion, or varying conditions of health, etc., and an occasional test would therefore be misleading. To avoid error on account of this, it is necessary to take the intraocular pressure in all cases, especially after operation, at least three times a day for a month afterwards, when it is possible.

Whether it is of scientific interest or not I shall mention that I had the experience of testing this man's intraocular pressure at a period of great anxiety, during which he stood to lose a great deal of money, having drilled an oil well which was apparently dry. I was with him at this time on the oil fields and probably was as much dejected as he was when

we left that night thinking that the well was dry. Next day the well came in a gusher and his anxiety was turned to joy by the fact that he was made at least a half a million dollars richer during the night. The intraocular pressure was taken frequently during these days, and was never above normal. Thus anxiety and joy failed to produce intraocular pressure after the operation.

In this case the hole in the iris made by the counterpuncture as shown by Figure 2 is useless, because it is not sufficiently far out in the periphery, and rests on the lens; consequently

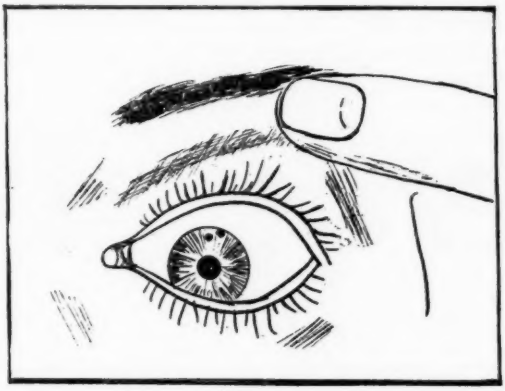

FIG. 2.

all the drainage comes through the peripheral hole, which is no more than half a millimeter in size. The result, however, being perfect, it was decided to make only one peripheral hole in future, and in cases of later glaucoma to make it a little larger in case there should be any small hemorrhage to organize and close it up. It has been abundantly proved that iris tissue never proliferates in aseptic non-inflammatory and non-hemorrhagic wounds. So if there is no hemorrhage and no iritis we can be certain that the drainage will be permanent. Further experiments showed that in late glaucoma it was necessary to make a similar iridotomy in another part of the periphery of the iris, preferably directly opposite the first one, a week or so afterwards. I have had to do this only in three cases out of the eighteen eyes which I have operated on.

The plan adopted in the following operations is well illustrated by A, B, and C. Fig. 3. The knife was passed through at the cornea-scleral junction. The iris was engaged by the point of the knife which on further pushing formed a little ruck in the iris, rendering the easy performance of a counterpuncture. (Plate B shows the point of the knife coming out under the iris.) The knife was pushed still farther with pressure directed upward, so as to cut through the iris transversal, making a hole about 1*mm* in size. Sometimes it was necessary to almost make a counterpuncture in the cornea in order to sever the intervening piece of iris. At times it was found that

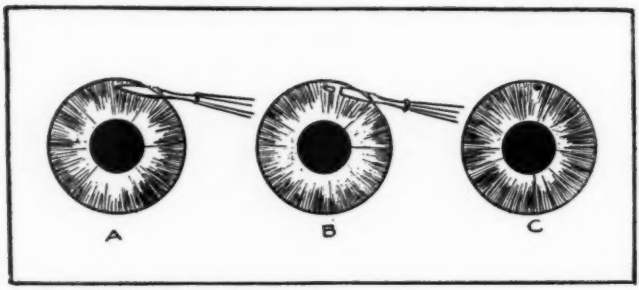

FIG. 3.

the first puncture made a hole in the iris sufficiently large and the knife was withdrawn without a counterpuncture in the iris. In cases of long standing in which there might be an occlusion of the canal of Schlemm, the knife was directed toward the ligamenta pectinati of the opposite side so that some of these would be cut by the point of the knife with the hope that free drainage into the canal of Schlemm would thus take place.

Fig. C shows the general appearance of the hole in the iris; after the operative wounds have healed, as will be seen by the picture of some of the other operations, this hole may differ in shape. Sometimes after the operation the pupil is slightly irregular, being flattened opposite the iridotomy.

I shall now give a very brief outline of cases operated on by this method. Only the salient points shall be mentioned, such

as the depth of the anterior chamber, thickness of iris, activity of pupil, field of vision, and intraocular pressure, etc.

These cases must not be confused with the six cases of small peripheral iridectomy described in general in this paper, and pictured for the one particular case by the photograph (Fig. 1); nor the case of acute glaucoma previously described and operated on by iridotomy. The tension in all these cases in which it is recorded was taken by the McLean tonometer, which I have found to be the most satisfactory after comparison with other tonometers before adopting it. It must ever be kept in mind, when we consider the varying size of eyes and curvatures of the cornea, that those who are familiar with the laws of mechanics will not concede that any tonometer up to the present date will give an accurate conception of the intraocular pressure of the eye; but no one will agree that an intraocular pressure thus taken is not of some value. The effects of an increased intraocular pressure will not be so disastrous in one eye as they are in another. A great deal depends on the elasticity and thickness of the sclera, the arrangement of the fibers as they pass through the cribriform lamina, and the density and strength of the cribriform lamina in relation to the elasticity and thinness of the sclera. In short, trauma of the nerve fibers as they pass into the optic nerve at the lamina is the chief disastrous effect of glaucoma. It must also be constantly kept in mind that under ordinary circumstances an intraocular pressure of 40*mm* of mercury measured by the McLean tonometer would be about equal to 26*mm* measured by the Shiotz or Shiotz-Gradle tonometer, and would be about the upper limit of the normal intraocular pressure, that is, a pressure which with the normal cribriform lamina would produce no trauma to the nerve fibers. On the other hand, a pressure which is much below this normal might produce considerable damage to the nerve fiber if the lamina cribrosa were very weak, as it undoubtedly is in simple glaucoma. Again, if the vision of an eye remained comparatively good at 60 or 70*mm* by the McLean tonometer for a considerable time, it might well be considered that these nerve fibers which survived under this pressure for a long time would have a chance of surviving indefinitely if the intraocular pressure were reduced by operation or otherwise to 45 or 55*mm* of mercury.

The intraocular pressure alone is not sufficient whether it is measured by the McLean tonometer, as it is in these cases, or by any other tonometer. We must consider the results in vision and in the subjective symptoms in estimating the success in the treatment.

CASE 2.—Female—white; age 47. Came to the University of Kansas Eye Clinic, complaining of dimness of vision in the right eye and complete blindness in the left, which had existed for two years in this state. Never had any pain in either eye. Sight in left eye went out unnoticed by the patient.

Examination. Right eye: $\frac{20}{20}$, with slightly contracted field of vision on nasal side.

Left eye: No light perception.

Intraocular pressure: R. 45*mm* of mercury; L. 88*mm* of mercury.

Measurement of cornea: R. 11*mm;* L. 11*mm.*

Iris: Color brown, and moderately thick, slightly curved to contour of lens.

Pupils: Left was larger than right and normal reaction to light and accommodation.

Anterior chamber: Right: moderately shallow; Left: more shallow than R.

Right: After instillation of eserine, the intraocular pressure became normal and remained so while under the drug.

Left: Intraocular pressure was reduced to 50*mm* under eserine.

March 7th: An iridectomy was performed on the left eye and on August 6th, the intraocular pressure in this eye was 28*mm.* There is a small filtering scar.

March 24th: The right eye was operated on by a small iridotomy ¼*mm* in size, as shown by Fig. 4, and the intraocular pressure on April 16th was 25*mm.* No eserine was used and no other treatment since the operation.

April 29th: The patient was kept under homatropin 1% for one day, after which the intraocular pressure was found to be 32*mm* of mercury.

September 5th: The intraocular pressure by palpation was normal. No difference in depth of the anterior chamber was observed, and the patient was put under 1% homatropin at 12 o'clock three drops every hour, which was continued until four o'clock.

September 6th: When the intraocular pressure of the

right eye was taken by the tonometer it registered 34*mm* of mercury. Two days of 1% homatropin instillations failed to raise the intraocular pressure and it was considered that this eye required no further treatment.

November 2d: The intraocular pressure was 35*mm;* the vision was unchanged and the eye had been comfortable in the interval.

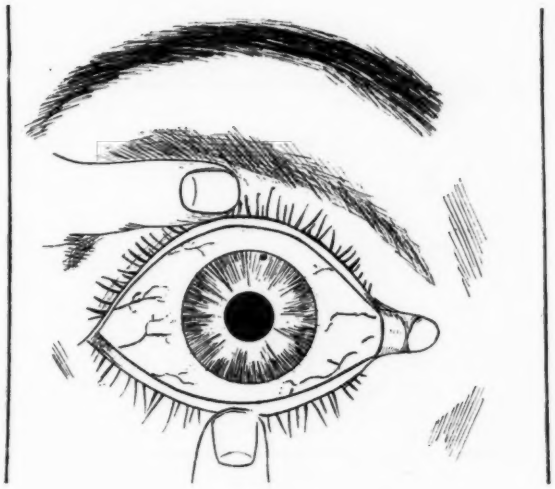

FIG. 4.

CASE 3.—Female, white. Under treatment for glaucoma in both eyes for two years; good response to eserine.

Vision: R. $\frac{20}{15}$; L. $\frac{20}{15}$.

Field of right eye contracted to 10° in the upper nasal segment quadrant, and to 30° in the temporal side. Field of left eye slightly contracted on the nasal side.

Intraocular pressure: R. 68*mm* of mercury; L. 67*mm* of mercury.

Cornea: 11*mm*.

Iris: Blue, and well marking the contour of the lens.

Anterior chamber: Shallow in right eye and less so in left eye.

Pupils: Active when not under eserine, but left more active than the right.

The eyes were doing well under ¼ of 1% eserine five times a day, and the patient went to her summer home in

Massachusetts at the end of May. June 2d her right eye became painful and red and she called me East to operate. On arrival the eye was found to be free from inflammation and the intraocular pressure normal; the eye of course was under eserine. A small iridotomy was done as shown by Fig. 5, which is a drawing showing results of operation in her eye. The operation was done in her own home and she was downstairs fifteen minutes afterwards, feeling no discomfort. The eye was normal in appearance and the anterior chamber deepened in a remarkable manner two days afterwards, and no further treatment was given the eye. Eight

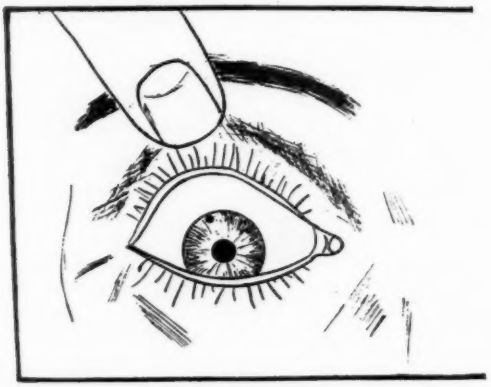

FIG. 5.

days after the operation this eye was kept under cocaine for two days with no rise of intraocular pressure. Previous to the operation holocaine or cocaine instillation would produce an immediate rise of intraocular pressure with pain. Fifteen days afterwards the eye was put under homatropin with the consent of the patient for one day, with no rise of intraocular pressure. The patient is now using eserine in the left eye, but nothing in the right eye, which is considered well up to this time. On October 1, 1919, the intraocular pressure was 37*mm* and on December 2, 1919, the pressure was 31*mm*. This patient has been under homatropin several times since September with no rise of pressure.

On Feb. 5th, 1920, the intraocular pressure was 35*mm*. No eserine was used since the operation.

CASE 4.—Colored, age 56; right eye blind from glaucoma with no light perception for four months. Appeared at

clinic May 28, 1919; dimness of vision in right eye began thirteen years ago. Right eye became blind two years ago with no light perception four months before. Left eye dimness eight years before which became much worse during the last year.

Vision: R. no light perception. L. $\frac{15}{30}$ with difficulty.

Intraocular pressure: R. 85; L. 70.

Lens changes both eyes. Fundus seen clearly.

Iris: Dark brown.

Pupils: Sluggish.

Anterior chamber: Very moderately shallow.

June 4, 1919: Small peripheral iridotomy done in upper part of the iris in both eyes, each about 1½*mm* in size.

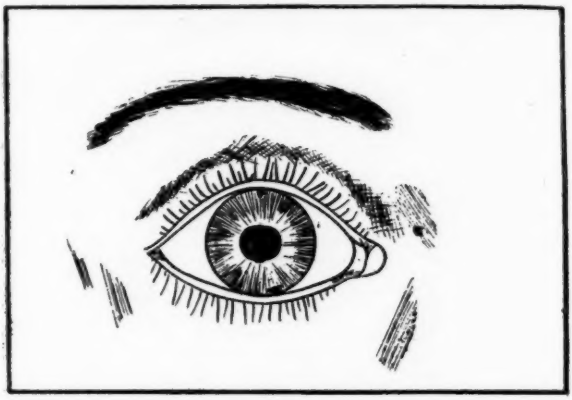

FIG. 6.

July 9, 1919: No treatment during the last five weeks. Intraocular pressure: R. 50; L. 37.

July 10, 1919: Intraocular pressure: R. 40; L. 37.

July 11th: The second operation of right eye on this day, small peripheral iridotomy as shown by picture in lower part of the iris.

July 14th: Intraocular pressure: R. 30; L. 40.

July 15th: Intraocular pressure: R. 39; L. 35.

July 18th: Intraocular pressure: R. 38; L. 38.

July 21st: Intraocular pressure: R. 30; L. 40.

July 23d: Intraocular pressure: R. 33; L. 31.

July 25th: Intraocular pressure: R. 35; L. 39.

July 28th: Intraocular pressure: R. 30; L. 40. Vision: R. No light perception. L. Two letters of $\frac{1}{15}$.

July 30th: Intraocular pressure: R. 32; L. 50.
July 30th: The second iridotomy in the lower segment of the iris of the left eye.
August 4th: Intraocular pressure: R. 32; L. 30.
August 6th: Intraocular pressure: R. 38; L. 34.
August 25th: Intraocular pressure: R. 38; L. 34.
August 30th: Intraocular pressure: R. 40; L. 37.
September 4th: Intraocular pressure: R. 45; L. 40.
September 6th: Intraocular pressure: R. 50; L. 40.
September 8th: Intraocular pressure: R. 53; L. 40.
Vision: Right hand movements out in temporal field. Left $\frac{1}{3}\frac{5}{0}$ with case and two letters of $\frac{1}{2}\frac{5}{0}$. No eserine was used from the first operation.

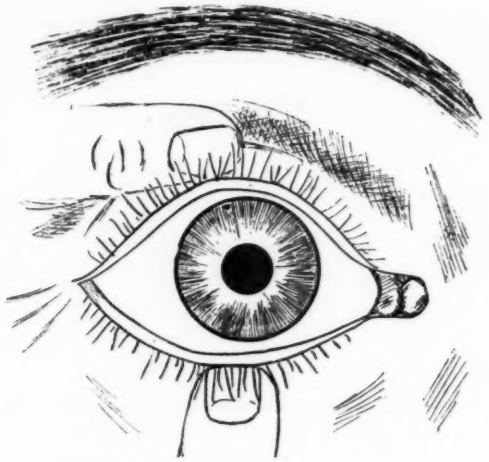

FIG. 7.

CASE 5.—Female; colored, age 48. Came to the clinic complaining of failing vision (April 8th) which began six years before.
Intraocular pressure: R. 47; L. 72.
Cornea: 11½*mm.*
Iris: Brown, thick and slightly curved to the contour of the lens.
Anterior chamber: Shallow in both eyes.
Eyes responded to eserine poorly and on May 16th a small iridotomy was performed in the right eye as shown by picture Fig. 7, and a larger one in upper part of left eye as shown by picture Fig. 8.

April 30th: Intraocular pressure: R. 38; L. 42. Vision: R. $\frac{15}{15}$; L. $\frac{15}{20}$. Still complains of dimness of vision in left eye.

Another operation was done in the left eye making two small iridotomies as shown by Fig. 8.

June 1st: Intraocular pressure: R. 40; L. 32. Both eyes vision clear.

June 28th: Intraocular pressure: R. 40; L. 38. Vision: R. $\frac{15}{15}$; L. $\frac{15}{20}$.

No treatment has been given since the first operation. Patient passed from observation.

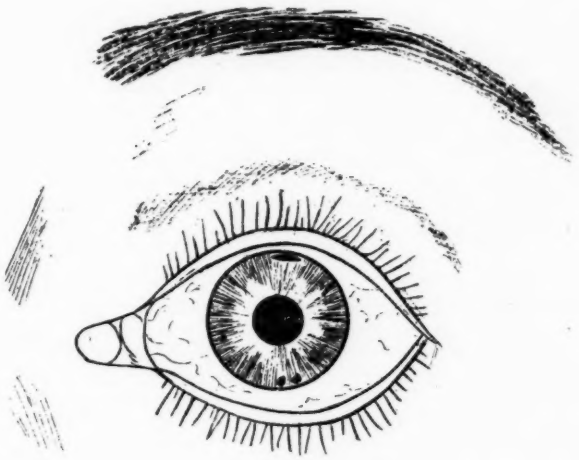

FIG. 8.

CASE 6.—Female, white, age 52. Came to clinic September 2, 1918. Iridectomy had been performed eighteen months before in left eye, at which time she could count eight meters away; left eye had previously been removed. Light perception and shadow movements in extreme periphery of temporal field in left eye. Intraocular pressure: 88.

September 12, 1919: An Elliot operation was done.

January 10, 1918: Intraocular pressure: 32.

March 6, 1919: Intraocular pressure: 40. Vision: Hand movements, increased light perception, slightly larger field. Can locate windows and doors in a room.

May 16, 1919: Intraocular pressure: 48.

A small iridotomy was done at the lower segment of iris

and the intraocular pressure since that time has never risen above 38*mm* of mercury.

September 6th: Intraocular pressure: 38*mm* of mercury. Vision unchanged. The filtering bleb of the Elliot operation had become much smaller since the peripheral iridotomy. Last tension taken November 16, 1919, 38*mm*.

CASE 7.—Female, white, age 55. Treated by Christian Science for glaucoma, when vision was good, for four years. Both eyes blind for two years. Appeared at the clinic in August, 1918. Intraocular pressure: R. 81; L. 89. Vision: Shadow movements in both eyes.

August 20, 1918: An Elliot operation done in both eyes. Intraocular pressure remained under normal throughout, and on May 30, 1919, was 30*mm* of mercury in both eyes. There was a rather large filtering bleb and with a view to reducing this a peripheral operation was done on left eye, after which filtering bleb began to recede in a marked manner. The intraocular pressure remained for about two months at 35*mm* of mercury, and patient has resumed her work as an actress, having sufficient vision to find her way about on the stage.

CASE 8.—Female, colored, age 45; left eye. Came to clinic May 8, 1919, complaining of great pain in her left eye. Vision had been failing in this eye for two years. Examination showed vision doubtful light perception in extreme peripheral of temporal field. Œdema of the lids; chemosis of the conjunctiva and steaminess of the cornea. Tension 100. A small iridotomy 4*mm* long was performed in this eye on the same date and patient went home. There was a good deal of bleeding into the anterior chamber, which was filled with blood and eye was still hard when she left the operating table.

May 12th: Patient returned to clinic; cornea now clear; swelling of the eyelids and conjunctiva had partially subsided. There was a blood clot round the periphery of the anterior chamber, seemingly occluding ⅔ of the filtering angle. The intraocular pressure was 60*mm* of mercury. Patient was much relieved from pain but eye was still very tender. Patient did not return to clinic. On August 12, 1919, I visited her home. The eye was quiet. Vision had not improved and intraocular pressure by palpation was normal or 4 to 5*mm* above normal. Patient was disappointed at no improvement in vision, and while her eye remained comfortable after the operation she could not be induced to return to the clinic.

CASE 9.—June 26, 1919, I was called to Independence, Mo., by Dr. Harris, to operate on a case of acute glaucoma. Patient was a female aged 72. I have not the past history to present. There had been great pain for several days, steaminess of the cornea, and shallowness of the anterior chamber.

Intraocular pressure: 65 (Shiotz-Gradle tonometer).

Vision: Hand movements.

Local anæsthesia had no effect and the patient was put under chloroform. A small iridotomy *4mm* in length was performed and when the patient was seen three weeks afterwards the eye was quiet and the vision $\frac{10}{100}$. The tension by palpation was considered normal. I have not seen the patient since, but her oculist reports that she is doing well, with a normal intraocular pressure. Last report December 2, 1919.

CASE 10.—Male, white, age 60. Came to clinic with absolute glaucoma in both eyes on January 26, 1919.

Intraocular pressure: R. eye 90; L. eye 100.

Right eye, slight œdema of the lids, and much inflammation of conjunctiva and eyeball. Left eye much œdema of lids, and great swelling of conjunctiva, much steaminess of the cornea, and great pain. He wished this eye removed. An Elliot operation was done in both eyes with *1mm* trephine. Peripheral iridectomy was easily made on right eye; the eye became quiet, and nothing further needed to be done to it. Owing to smallness of trephine hole an iridectomy was not successful in the left eye, and although this eye was much improved the intraocular pressure remained about 60 until May 28, 1919, when a peripheral iridotomy *3mm* in length was performed in this eye; the anterior chamber has deepened and intraocular pressure has remained at *50mm* of mercury ever since. There is no pain in the eye, but there is still some pericorneal injection and August 28th there was, of course, still no light perception in the eye, but occasional light perception returned to the right. Up to December 2, 1919, the patient has not returned to the clinic.

CASE 11.—Male, white; age 62, had been under treatment at my office for one year and a half for chronic primary glaucoma. Came back for observation March 20, 1919.

Vision: R. $\frac{20}{30}$; L. $\frac{21}{100}$, which was unchanged from beginning of the treatment. Eserine was omitted for two days, when the intraocular pressure was taken and found to be R. 50, L. 60.

An iridotomy was attempted on the left eye, and there

was a good deal of bleeding, so much that it could not be seen whether a hole in the iris was made or not. The patient left the hospital immediately afterwards. As he could not be kept under observation he was cautioned to use the eserine in both eyes. On July 16th he returned. The eserine was omitted for one day, and on July 18th the intraocular pressure in this eye was 60. A careful examination was made, but no hole in the iris was detected. As the patient lived over three hundred miles away and could not remain in town over that day he was advised to continue use of eserine. An iridectomy will be performed later.

CASE 12.—Male, white; age 56. Came to clinic June 15, 1919, complaining of dimness of vision in both eyes, which began five years previously. Patient was under treatment in the Department of Neurology for tabes dorsalis.

Vision: R. $\frac{15}{30}$; L. $\frac{15}{30}$. Field of vision much contracted on nasal side; much on temporal side in both eyes.

Intraocular pressure: R. 45; L. 56.

Cornea: 12*mm.*

Anterior chamber: Shallow.

Iris: Blue, thin, and showing the contour of the anterior curvature of the lens slightly. Pupils did not react to light, with slight reaction to distance. The patient was placed under eserine ½ of 1% three times a day, and on June 20th the intraocular pressure was unchanged. He was ordered to use the eserine every two hours and on June 30th intraocular pressure: R. 40; L. 50. This was not considered sufficiently reduced so that the patient was again put under eserine every two hours for two days, and on July 2d, the intraocular pressure still remained—R. 40; L. 50.

July 15th: Intraocular pressure: R. 39; L. 51. Iridotomy done on both eyes.

August 2d: Intraocular pressure: R. 39; L. 45. No eserine was used since July 2d.

September 2d: Intraocular pressure: R. 39; L. 46.

Vision: R. $\frac{20}{30}$; L. $\frac{20}{40}$. Field of vision in both eyes increased slightly. Patient appreciates that he can see much better than before the operation was done. One half of 1% eserine was used every two hours from September 6th with no alteration in intraocular pressure, although the pupils contract greatly under its use. Eserine failed to have any effect whatever in reducing pressure in this case either before or after the operation. Another small iridotomy was done in the left eye. The pressure, however, has been keeping up since October 16th. Preliminary fall after the operation was due to filtration through the puncture. It is now R.

40, L. 50. The operation is considered a failure in this patient.

CASE 13.—Female, colored; age 50. Came to clinic July 26th. Complained of slight dimness of vision in right eye and blindness in the left.

Vision: R. $\frac{4}{10}$. L. No light perception. Intraocular pressure: R. 42; L. 81.

3*mm* iridotomy was performed in the left eye and the patient went home immediately.

August 16th: Intraocular pressure: R. 40; L. 50.
September 6th: R. 40; L. 45.
September 12th: R. 30; L. 30.
September 17th: R. 25; L. 39.
September 19th: L. 42.
September 22d: L. 43.
September 24th: R. 35; L. 50.
September 29th: R. 35; L. 50.
October 15th: R. 33; L. 50.
October 20th: R. 30; L. 40.
October 31st: R. 35; L. 40.
November 3d: R. 30; L. 30.

No eserine was used in either eye. Vision unchanged.

CASE 14.—Office patient; male, white; age 53; first seen on August 16th.

Intraocular pressure: R. 85; L. 75.

Vision: R. $\frac{4}{100}$; L. No light perception.

Cornea: 11*mm*.

Lens: Posterior lens opacities.

Iris: Blue, thin; anterior chamber very shallow; pupils reacted slowly in light and distance. Field reduced to 20° on nasal side with cotton ball 5*cc* in diameter.

September 16th: Iridotomy done in both eyes 5*mm* long. The knife was sharp and a larger iridotomy than intended was performed and in each eye a few fibers of the iris became entangled in the wound, making a filtering scar in both eyes, a condition which was not intended.

August 10th: Intraocular pressure: R. 35*mm* of mercury; L. 45*mm* of mercury.

Vision: R. $\frac{13}{100}$; L. slight uncertain light perception on the nasal field. The anterior chamber did not deepen, owing to filtering scar, and this was considered unsatisfactory, though no doubt the intraocular pressure will be permanently decreased.

October 13, 1919: Tension: R. 52; L. 56.

November 13, 1919: Tension: R. 54; L. 60. Vision: R. $\frac{4}{100}$; L. no light perception. Anterior chamber still shallow.

Lens opacities increased. Field of vision increased to 30° on nasal side. Diminution of vision evidently due to lens opacities. No lens opacities at site of iridotomy and he can see better through this hole than through the pupil as the lens opacities are central.

December 15th: Cataract extraction right eye.

January 10th: Intraocular pressure: R. 30; L. 50.

February 17th: Intraocular pressure: R. 38; L. 52.

Vision in right eye $\frac{20}{100}$. Large stringy and network floating vitreous opacities.

Case 15.—Office patient, male, age 53; white. First seen August 10, 1919.

Vision: R. $\frac{18}{18}$ with difficulty. L. $\frac{18}{18}$.

Intraocular pressure: R. 77; L. 80.

Iris: Blue, thin, and showing contour of anterior curves of lens moderately.

Anterior chamber: Moderately shallow.

Pupils: Sluggish.

August 16, 1919: Iridotomy attempted on right eye. Not sure of success. Iridotomy on left eye *2mm* in size. Patient kept in hospital for two days.

August 18th: Both eyes comfortable.

August 26th: Examination failed to reveal any hole in right iris.

Intraocular pressure: R. 30; L. 25. McLean tonometer.

August 30th: Intraocular pressure: R. 40; L. 30.

September 6th: Intraocular pressure: R. 40; L. 35. Left eye put under eserine.

September 10th: Intraocular pressure: R. 40; L. 35. Under eserine a minute hole was observed in the iris.

September 16th: Intraocular pressure: R. 40; L. 38.

It is probable that when the eserine is discarded, the small hole in the iris will not function so well, and a larger hole will be made in future, though even this may not be necessary. A very slight deepening of the anterior chamber was observed in both eyes. Since the above was written the following is the report continued.

October 28th: Tension: R. 45; L. 36. Vision: R. $\frac{18}{30}$; L. $\frac{18}{18}$.

November 21st: Tension: R. 55; L. 43. Vision unchanged. Evidently the filtering angle is not sufficiently open to drain these eyes.

In studying these cases it is necessary to consider the effects of puncture of the eye; if the puncture is made in the cornea, it is sealed in a few hours, and if there is no loss of aqueous the

intraocular pressure will not immediately be reduced, but on the other hand may be slightly increased, owing to the instillation of cocaine for the operation. In such a case the fall of intraocular pressure will be noticed the next day, but if the puncture is made say 1*mm* from the clear corneal tissue on the scleral side, where it is more vascular, the sealing of the wound does not take place so readily, and even when the wound is healed and quiet, say after ten days, we must be suspicious of some filtration through this scar, which, however, gradually closes completely. In this manner we can account for the gradual increase in tension in some of the advanced cases above described. In an advanced case the anterior chamber with its filtering angle is not fully restored with the operation in such cases, so that the intraocular pressure, though very greatly reduced, is not reduced to normal. In the very early cases, however, the anterior chamber is fully restored, and the filtering angle can take care of the change of aqueous permanently when the filtering scar is firmly closed. It seems that even if a filtering scar were found necessary in the advanced cases it would be better to perform this operation first and get the anterior chamber as fully restored as the pathology of the case would allow. We can tell when the anterior chamber is thus restored to its fullest extent by watching the intraocular pressure rise gradually until it comes to a point where it remains permanent. If this is not too high an intraocular pressure and the field and vision keep constant, although the intraocular pressure is moderately high, it may be considered that the nerve fibers which have already been under very high intraocular pressure for a long time will function indefinitely; but of course the eyes must be kept under close observation. In early cases where the anterior chamber had been originally shallow and has been definitely restored to normal by the operation, no such constant observation is necessary.

THE THERAPEUTIC USE OF RADIUM IN DISEASES OF THE EYE.[1]

By HENRY H. JANEWAY, M.D., New York City.

ALTHOUGH the Memorial Hospital has been using radium for five years, the eye cases, which have been referred to it for treatment, have been few until the last year or so.

Our experience has been limited to:

7 cases of sarcoma
1 case of old keratitis
6 cases of glioma
3 cases of nævi of the eyelids
12 cases of vernal catarrh
1 case of epibulbar melanosarcoma
2 cases of epithelioma of the scleral conjunctiva
60 cases of epithelioma of the eyelids

SARCOMA

Of the seven cases of sarcoma four tumors were intraorbital sarcomas. Two of these intraorbital tumors treated earlier in our experience were not improved. One, however, treated recently and referred to us by Dr. Knapp has been much improved.

This patient is a child six years of age. Eight weeks before she came to us, a swelling developed in the orbit, appearing more prominent above the eye and to its inner side and displacing it downwards and outwards.

She received three treatments over the eye which produced

[1] Read before Section on Ophthalmology, New York Academy of Medicine, November 19, 1919.

a marked reduction, almost a complete disappearance of the growth. It recurred and removal of the eye was advised, in order to permit of treatment without filtration of the radium from within the cavity of the orbit. After removal of the eye this treatment was given on August 21, 1919. 47*mc* of unfiltered radium emanation were placed in the center of the orbital cavity for twenty-four hours. We have since heard that this child died late in December, 1919, of meningitis secondary to mastoiditis.

When last seen during this month there was no evidence of disease in the orbit though the inflammatory effect from the treatment was severe and had not disappeared.

Three patients with sarcoma, primary as far as could be ascertained, in the choroid have been treated.

One of these patients, an old lady 65 years of age, was referred to us by Dr. Denig. The diagnosis was made in February, 1915, but the patient postponed operation until November, 1918. Section confirmed the diagnosis. She was referred for treatment July 23, 1919. At that time she had a huge tumor filling the orbit and extending backwards beneath the skin of the temple for 5*cm*. The treatment produced only a very temporary improvement.

The second patient, a young man 31 years of age, developed his lesion fourteen months before applying for treatment. His eye was removed December 15, 1917, and treatment was begun at the Memorial Hospital, April 30, 1918. At that time the orbit was filled with a tumor mass which was continuous with a hemispherical firm smooth mass on the frontal bone three inches in diameter at its base. He received eight treatments between April 30, 1918, and April 30, 1919, which produced a considerable reduction in the size of the mass and continued improvement was reported on July 18, 1919. The improvement continued until February, 1920, when renewed activity of his disease manifested itself.

The third patient was a young lady with an early intraocular sarcoma of the choroid. She received treatment and subsequently enucleation was performed. Sections of the tumor showed no evidence of any effect produced on it by the radium treatment, the first of which had been given two months previously.

From our experience limited thus far to merely three choroidal sarcomas and four intraorbital sarcomas we may conclude that radium will produce a temporary improvement, though not a complete retrogression in advanced lesions.

This marked susceptibility, which the large recurrent growths have shown, indicates that cures may be expected in some cases, if the recurrences can be treated early. Moreover an early recurrent growth can be treated more effectively because of its accessibility to the use of buried emanation, a more powerful method of handling it than the surface application alone. Certainly every case operated upon should be given the benefit of one post therapeutic prophylactic treatment. As regards the treatment of early sarcoma of the uveal tract the evidence at hand does not support the view that radium should replace enucleation.

Enucleation has been followed by alleged good results in early sarcomas of the uveal tract. The average percentage of cures in thirteen reports is 40%. These percentages vary between 6 and 83%. Every variation exists according to the type of sarcoma and the stage of the operation. The high percentages of cures belong to the spindle cell sarcoma and to the stage before the coats of the eyeball have been perforated.

The anatomical structure of the eyeball more completely isolates a tumor in an early stage than do most regions of the body. Enucleation in an early stage, a stage easily diagnosed in the eye, is so successful that with our present knowledge it should be the method of choice in the treatment of sarcoma of the ciliary body or choroid. A possible exception may be made to certain sarcomas of the iris and to epibular sarcoma. A trial by radium within the limits, within which it is safe to postpone operation, is permissible in certain cases of sarcoma of the iris. In epibulbar sarcomas a number of good results have been reported from radium treatment. We have one patient with such a tumor, whom Dr. Weeks referred to us. She has received thus far but one treatment given several weeks ago and at present is doing well. These growths are frequently small when the patient applies for treatment and are very superficially situated so that they can be easily and thoroughly exposed to radium and a trial should be given it before the more radical method of operation is resorted to.

In sarcoma of the orbital cavity external to the eyeball radium plays a very much more important rôle. Our experience does not support the view that in these growths it will save the eye yet it encourages the belief that it will save the life of the patient. After a preliminary radium treatment, exenteration should be performed and afterwards a post-operative treatment by unfiltered radium placed by cotton support in the center of the orbital cavity.

1000*mc* hours is not too heavy a dose.

A severe reaction may follow but if the growth has not already metastasized the patient's life may be saved.

The following reports furnish some idea of the operative result alone in the sarcoma of the eye:

Griffith reports fourteen patients of forty operated on who were alive three to ten and one half years after operation—35%.

Martin reports 62% recoveries in thirty-five cases of sarcoma of the iris.

Of six traced patients subjected to simple iridectomy for sarcoma of the iris, Wood and Pusey report five patients free from recurrence for three or more years; and favorable results to date were obtained on fourteen other cases. Eighty-five per cent. of primary sarcoma of the orbit are unclassified as to origin.

Sterling reports thirteen of twenty-nine patients well after operation of whom four were operated on three years previously. Recurrence occurred in nine of ten cases in which a local removal alone was performed. Of sixteen patients in whom complete evisceration was done seven were free from recurrence at time of report. Three patients were untraced.

Fuchs collected from the literature 221 sarcomas of the choroid and twenty-three of the ciliary body; of these 6% were cured by operation. In addition to these he adds 23.53% of seventeen of his own cases.

Lawford and Collins report 103 cases of sarcoma of the uveal tract; of these seventy-nine cases were traced of which thirty-nine are still alive. Twenty or about 25% have passed the three-year limit. Of the forty patients who died, death certainly took place from metastases in twenty-six and probably in others. Local recurrences occurred seven times.

Marshall published later a report of the 103 cases origi-

nally reported by Lawford and Collins. In 1903 only six cases of the thirty-nine patients, well at the time of the first report, remained alive. Of the additional deaths nine were known to be due to recurrences and eleven most likely were. Seven of these deaths occurred after the three-year limit. These new figures change the percentages of recurrences to 58.62% from 32.9%. Marshall reports fifty-eight new cases. In fifty-six enucleation of the eye was done and in two others later an evisceration. Twenty-four patients are still alive and eleven after an interval of three years and over. Six of the whole fifty-eight cases died from recurrence (two of local recurrence) and twelve are untraced. Excluding these, death occurred from recurrence in 13.04%.

Freudenthal reports twenty-four cases of sarcoma: twenty-one enucleations were performed; three eviscerations of the orbit; six cases were known to have developed a local recurrence; four others distant metastases; six patients or 37.5% were free from evidence of recurrence three years after operation.

Hagen reports twenty-eight patients operated on for sarcoma of the choroid. Twenty-four of twenty-eight traced for three and one half years. Twelve are well. Two died from other causes twelve and twelve and one half years after operation, the percentages of cures being, therefore, 58%. The percentages of cures with other writers varies from 6–56%. No recurrent lesions developed in any patient operated on before the ocular coats had been perforated. Metastases occurred with few exceptions during the first four years, the greatest danger being in the first six months. A patient may be regarded as cured with fair degree of certainty if well after the elapse of four years after operation.

The intensity of the pigmentation of the tumor bears no relation to the prognosis.

Moulton confirms Hagen's report regarding the favorable prognosis when the patient is operated on before penetration of the ocular coats. Four such patients with sarcoma of the choroid operated on by him were well, two, five years after operation, one three years after, and one a few months after operation.

Verhoeff and Loring collected from the literature fifty-three

cases of primary epibulbar sarcoma removed by local excision. Forty-four of these were traced and only eight were well six months to ten years after operation; thirty-six or 81.8% developed recurrence; nineteen cases were treated by primary enucleation and nine had deep extension or metastases at time of operation; of the total fifty-four traced cases metastatic recurrence developed in 12 or 22%.

They consider epibulbar sarcoma usually a very malignant tumor but capable of early diagnosis in a stage of still very circumscribed infiltration because of the superficial location and the resistant character of the cornea and sclera.

The result after local excision have not been good and after the diagnosis has, therefore, been established by section, enucleation is the operation of choice.

Goldchtein reports seventy cases collected from the literature in which enucleation was practiced with no metastases or recurrences in sixteen of twenty-three traced patients.

Strouse reports rather a different conclusion on sarcoma of the corneal limbus, though his facts do not well support this difference. Metastases never occur nor invasion of the eyeball. Exenteration or enucleation are, therefore, never justifiable. He reports twenty-four cases: Five recurred within several months to two years. Six alone believed to have been cured; the duration of the postoperative period is not given.

La Grange (vol. i., pp. 467–) who has made a most careful pathological study of the ocular sarcomas reports thirty-three patients traced after operation. Eighteen were free from recurrence for one year and fifteen died of recurrence. Of these fifteen cases thirteen were tumors of a more round cell type. He believes that prognosis after operation is fairly favorable in the spindle cell growth of the unpigmented type of tumor. He believes that a little less than 25% are cured by operation.

As is true with our own cases, the reports upon the radium treatment of sarcomas of the eye is practically limited to recurrent growths. The majority of these reports have also corresponded with our experience.

Finzi reports a complete retrogression of a twice recurrent sarcoma in the orbit after three treatments with 150*mgr* of radium bromide filtered through 2*mm* of platinum.

Flemming showed two cases of sarcoma of the eyeball suc-

cessfully treated with radium and an apparent complete cure. First case was treated over two years ago.

Klock reports two epibulbar sarcomas of the eye, one covering the cornea and the other extending over the papillary area, apparently cured by radium and a third case of melanosarcoma of the ciliary body extending into the papillary area and displacing the iris forward, greatly reduced in size.

Heckel reports one case of epibulbar sarcoma successfully treated by X-rays.

Snell reports a melanosarcoma occupying the inner ⅔ of the cornea conjunctival limbus, which disappeared after twelve X-ray treatments. There was no recurrence two years and seven months later.

Van Duyse reports a case in which there was freedom from recurrence of seven months' standing after total exenteration for recurrent sarcoma of the orbit by the X-rays.

In sarcoma of the eyelids we have had no experience, but from our experience with sarcoma elsewhere it is a lesion which should yield well to radium, presumably by embedding emanation in the growth. Alling has collected sixty-five cases of sarcoma of the eyelid from the literature. Recurrence was the rule after operation for these growths. One case, however, was free from recurrence for thirteen years and another for five years.

Dr. Abbe, as early as 1910, reported a cure of five years' standing of a sarcoma involving ⅔ of the lower lid by the application of radium.

KERATITIS

The case of interstitial keratitis is in a girl twenty-four years of age, having started twelve years before she began treatment with us. The patient had received every form of treatment, including, of course, antisyphilitic treatment, without benefit. The seven radium treatments, between January 24th and October 1st of this year, which we administered, produced also no improvement. Because, however, of the favorable effect on chronic inflammatory processes in the cornea reported by others, particularly by MacKenzie and Cuperus, it may be that failure in our case was due, in part at least, to

the age and chronic character of the lesion, though these favorable results in inflammatory conditions have not been duplicated by others.

In treating inflammation of the cornea we recommend that the radium emanations be filtered through ¼ to ½*mm* of silver, applied at a distance in front of the cornea of at least 1*cm* and a dosage of 60 to 100*mc* hrs. We have had no further experience in diseases of the cornea than the single case above referred to and no experience whatever in the treatment of disease of the iris.

Mattice reports the successful treatment of a corneal tumor with radium. He also refers to Koster's work, published by Leiden in 1905, in which radium gave very favorable results in a number of chronic inflammatory conditions of the cornea, iris, and choroid, and no effect at all in retinitis pigmentosa or optic nerve atrophy. He also failed, contrary to the experience of Levin and Cohen, in cataract of the lens. Levin, at the last meeting of the A. M. A., gave a most favorable report of the treatment of cataract by radium.

GLIOMA

Of the six patients with glioma of the retina, one patient whom Dr. Schoenberg referred to us and who was exhibited to this section last spring, has done remarkably well.

This patient, a child, now of four years, had the left eye removed in December or November, 1916, and was treated for glioma of the left retina by radium April 10, 1917, and since this time, as far as I have been able to discover, the condition has remained stationary and the child now sees well.

Of the other patients treated, the subsequent fate can be traced in only three. One of them, a child of twenty months, in which the left eye had been previously removed and who had an advanced glioma almost completely destroying the vision on the right eye, was treated six times between May 25, 1918, and March 7, 1919, with heavy dosage.

The treatment, so far as can be ascertained, produced no change in the course of the disease, and the child is now dying from assumably cerebral metastases. This, of course, does not mean that the radium has not produced a local destruction of

the tumor. The other two patients are still under treatment. One of them had an advanced glioma in both eyes, so that the subsequent fate is also of comparatively little importance. The other and only remaining patient, 6½ years of age, was referred to us by Dr. Knapp. The left eye had been previously removed and the right eye contained a growth, in perhaps what may be termed the second or moderately advanced stage of glioma.

He has received to date three heavy treatments between June 23, 1919 and October 6, 1919, and Dr. Knapp reported to me when he last examined the child that he thought the process, though a little more advanced than at first, had lately shown some improvement. We have heard lately by letter from the child's mother that the vision is becoming much worse.

To-day, therefore, much the same conclusions must be drawn about glioma of the retina as about sarcoma of the choroid, but perhaps with a little greater leaning toward the treatment by radium as opposed to operation. The same isolation of early glioma retinæ by the coats of the eyeball exists as was emphasized in the consideration of early sarcoma of the choroid. Therefore, our experience, as in choroidal sarcoma, so also in glioma of one eye, demands operative removal. The average percentage of operative cures of glioma in six reports by Adam, Holmes, Carlo, Owen, Wintersteiner, and La Grange, is about 46%. This percentage is probably very high and 13% to 21% of a large number of cases collected from the literature by La Grange plus additional cases of his own is more accurate.

Adam, in reviewing all cases during twenty years treated at the eye clinic in Berlin, traced the fate of forty-four of forty-seven patients, of which 54.5% were cured by operation. He concludes that an enucleation undertaken in the first stage in which the glioma is still confined within the eyeball gives 93% cures. He reports no patient cured by operation for recurrences. Extraocular extension of the disease occurred in seventeen cases and only one of these remained well for three years. He has collected eight cases from the literature which, in spite of the fact that extension had occurred to the optic nerve, were saved by enucleation or evisceration of the eyeball.

Holmes reports four cases cured by operation, all at the end of the first stage.

Carlo reports sixty cures of glioma of two years' standing and nine of one year's standing, out of 252 cases operated on. Of the recurrences only three occurred after twelve months' time. He confirms Adam's report on the bad prognosis for recurrent cases. Of thirty-nine cases of bilateral glioma, seven were well after two years following double enucleation.

Owen reports twenty-four patients operated on for glioma of the retina. Of these eight were well eight and one half months to eight years later.

Wintersteiner reports cures of three years in 16% of cases of glioma operated on.

La Grange (vol. i., pp. 676–) has collected twenty cures of cases of glioma of the retina reported up to 1890. In addition to these he quotes the table of Wintersteiner, summarizing 497 cases of glioma retinæ, of which there were sixty-eight cures with a postoperative period varying between two and twenty years, a percentage of 13.6.

La Grange adds eight new cases of his own, four of ten years, one, eight years, and three, two years or more. Further he adds a table of provisional cures in twenty-six cases with a postoperative history of six to eighteen months.

While we recommend, therefore, enucleation in primary glioma of one eye, it may be justifiable to use radium alone, or at least leave the decision entirely in the hands of the parents, if a tumor is discovered in the other eye, after removal of the one eye, when glioma proves to be bilateral, as it is in about 23% of the cases.

The method of treatment is the same advised for choroidal sarcoma, a dosage of 3000*mm* hrs. at a distance of 3*cm* and filtration through 2*mm* lead applied over the temple and in front of the eye.

Others have favorably reported the use of radiation in glioma. Purtscher strongly recommends radiotherapy with Roentgen rays after the technic devised by Axenfeld in glioma.

Duncan reports three rather advanced cases of glioma of the retina cured by the application of radium after operation, in one case after the recurrence had taken place. Axenfeld is very enthusiastic over the treatment of glioma retinæ with

X-rays. He reports the disappearance of an early lesion in the eye of a patient whose other eye had been removed for glioma.

He recommends X-ray therapy in early gliomatous eyes and even after enucleation for early gliomas and recurrent lesions.

NÆVI OF THE LIDS

Excellent results have been obtained in the treatment of nævi of the lids. We have treated more than three cases, as many of these nævi are classified as lesions of the skin. In all of the three cases here reported, the red birthmark has been replaced by a cutaneous surface only slightly paler than the normal skin.

The majority of these lesions occur in children and the treatments are best made short. Moreover, the majority of these lesions are superficial and little filtration is needed. The very superficial lesions are treated with filtration of only .2*mm* aluminum at a distance of .5*cm*, giving a dosage of 12 to 15*mc* hrs. per sq. cm. We recommend for irregularly shaped, larger, superficial nævi the use of applications very carefully shaped to the contour of the lesion, upon which the radium must be uniformly distributed.

Deeper nævi may be treated with .5*mm* of silver filtration at the same distance from the skin and a dosage of 40 to 60*mc* hrs. per sq. cm according to the extent of the lesion.

In other parts of the body large cavernous nævi or angiomata forming discoid elevations have been successfully treated with emanation buried in the center of the tumor.

VERNAL CATARRH

The treatment of vernal catarrh by radium has been most successful. This disease has long been considered one of the most rebellious of the inflammatory conditions which comes to the ophthalmologist, the usual conjunctival application and methods of treatment seldom producing much, if any, effect. A single radium application is capable of producing an improvement approaching a cure. Sometimes a second treatment is necessary.

During the past two years we have treated twelve patients

and all of them have been so improved that they may be regarded as closely approaching a cure.

Due to inexperience in a few of the earlier cases, some little scarring has been produced, but never to a degree which has seriously diminished the return of the conjunctiva to its normal function.

The method now adopted is the application to the tarsal surface of the conjunctiva of a very thin .1*mm* piece of lead cut to accurately fit the tarsus and evenly covered with the active deposit from emanation.

Such a method makes possible an absolutely uniform distribution of all the therapeutic radiations from radium, in complete equilibrium to the surface of the tarsal conjunctiva. It also permits of making the application from a flexible soft piece of lead which can not only be inserted between the orbital and the tarsal conjunctiva but can even be covered by folding another piece of lead of the same thickness over it in such a way as to filter the side against the orbital conjunctiva through .2*mm* of lead. The three layers of lead then form an applicator .3*mm* thick, which is still very flexible and still capable of insertion between the tarsal and the orbital conjunctiva. We have followed this method in the treatment of our series of vernal catarrh cases and the results have been good. The irritation due to the more heavily filtered radiations falling upon the orbital conjunctiva plus also a certain amount of secondary radiations have proved to be harmless, in fact, no evidence of this irritation has been manifest later.

If, however, the surgeon wishes to evert the lids and treat only the tarsal conjunctiva for the sake of assuring the orbital conjunctiva a still greater protection, the upper lids may be everted and so held during the whole time of the application by the pressure of the same activated lead fastened with paraffin to the end of a hand-held wooden holder cut to a corresponding shape. The reason for cutting the end of the holder to the same shape as the activated lead is to ensure accuracy of application. We have not used this method because of the inconvenience of holding such an applicator, and finally because no harm has resulted from the simpler procedure of slipping the applicator under the lid in its normal position. Of course the eye is cocainized during the treatment.

In any case the use of active deposit instead of radium tubes is a better method because of the far greater uniformity in the distribution of the radium activity by this method than when single tubes are used.

Our dosage has varied from 200 to 400*mc* min. by these activated applicators. With applicators of 50 to 100*mc*, the total duration of the exposure is only four minutes.

Excellent results have of course been obtained by other methods.

Butler reported two cases in which he applied 45*mgr* for five minutes, 7*mgr* for eight to fifteen minutes, respectively, in tubes to the everted lids. These treatments were repeated once in the first place and five times in the second.

Shumway reports an excellent result in a boy who for five years had resisted all other treatment. He gave five treatments of 35*mgr* for fifteen minutes.

Pusey has treated a number of cases during the past few years in some instances with X-rays and in other cases with radium.

He has applied 5*mgr* of the element over the lid just short of contact for about thirty minutes, each portion of the surface of the conjunctiva getting about ten minutes. The application lasts five minutes on six successive days. The treatment is repeated after several months. He considers X-rays as efficacious. All his cases were of long-preceding duration, severe, and unyielding to other methods tried. His results were very gratifying.

Dr. Shine showed a case of vernal catarrh treated with radium at the Academy, October 16, 1916. Four treatments of 20*mgr* of from twenty-five to thirty-five minutes' duration were given. He reported treatment of four other cases and all did well.

Dr. Crigler presented two good results on May 20, 1918.

Lawson and Davidson report two cures, in the first case treated with 39 to 44*mgr* in eight exposures extending over twelve months, and the second six exposures during four months, each exposure lasting ten to twenty minutes.

A review of these reports demonstrates the simplicity and greater accuracy of the use of active deposit after the method described.

EPITHELIOMA OF THE ORBITAL CONJUNCTIVA

In this disease and in epithelioma of the lids, quite as much as in vernal catarrh, if not more so, radium has performed, in the experience of the Memorial Hospital, a service which is not too much to term indispensable.

I have collected the results in two cases of epithelioma of the orbital conjunctiva and sixty cases of epithelioma of the lids.

Both patients with orbital epitheliomas were referred to the hospital by Dr. Weeks.

The first patient, a man of fifty-seven years, was treated on December 20, 1917. At that time he had a nodular elevation on the scleral conjunctiva near the outer lower portion of the periphery of the cornea of the left eye and a pterygium-like extension on the adjacent surface of the cornea. The trouble was first discovered eight months before. The diagnosis was made clinically.

On December 20, 1917, 42*mc* of emanation unfiltered was applied by a brass cone at a distance of 1*cm* over the lesion for twenty minutes. On September 30, 1918, the local ophthalmologist reported that the lesion had undergone continuous retrogression and at that time the patient was still free from any evidence of disease.

Inasmuch as no microscopical diagnosis of this case was made, it may have been benign in its character. The previous existence of the growth for only eight months is, however, against the view.

Two such benign cases have been reported cured by mesothorium, one by Koellner and another by Agricola.

The second patient was a girl twenty-five years of age. Twelve years before applying for treatment a small reddish colored spot had developed external to the outer quadrant of the cornea on the bulbar conjunctiva. One and a half years before applying for treatment, it began to increase in size and became elevated. Two months before treatment it had been excised and a microscopical section confirmed the clinical diagnosis of epithelioma. Four X-ray treatments were given after the operation but the growth recurred and on September 19, 1917, two grape-seed sized nodules separated by a cicatrix were present on the scleral conjunctiva external to the corneal margin.

Five treatments, probably an unnecessary number, were given between September 19, 1917, and December 15, 1917, as follows:

September 19, 1917, 30*mc* filtered by .5*mm* silver were applied at a distance of 1*mm* in an applicator made of dental modeling compound for one hour;

October 18, 1917, 100*mc* were applied in the same manner for fifteen minutes;

On the other dates, 20*mc*, 46*mc*, and 38*mc*, respectively, were applied at distances of 1 to 1½*cm* in cones for twenty minutes.

On September 30, 1918, and ever since to date, there has been no evidence of the disease.

Such treatments as these are therefore efficacious in destroying epithelioma of the orbital conjunctiva and do the retina or cornea or rest of the eye no harm.

Though both these patients received treatment by means of the brass cone applicators, we now recommend the first method used, a hole approximately .5*cm* to 1*cm* in diameter cut in a piece of 2*mm* lead, one or two radium tubes placed over its center and fastened to it by paraffin. The eye is then opened by means of one of the regular lid separators and a spot marked in such a position on the wall of the room that when the patient fixes the gaze upon it, in a convenient position of the head, the growth on the orbital conjunctiva occupies a high position in the middle of the speculum over which now the applicator may be placed. We recommend silver filtration and two applications at relatively near dates of 30*mc* hours each.

The cure of a case similar to our own, by radium, has been reported by Collins in 1915.

EPITHELIOMA OF THE LIDS.

Equally brilliant results have been obtained in the treatment of epithelioma of the lids.

A successful result has been obtained in practically all of these cases. This does not mean that a cure to date has been obtained in all, nor does it mean that in many advanced cases the eye was ultimately saved.

It does mean that early epitheliomas of the lids have been

cured to date, often by single applications, and that the eye has been saved. In other more advanced cases it was necessary to sacrifice the eye in order to properly treat the lesion.

A few patients having advanced recurrent lesions or lesions having had a long course of previous treatments by various methods or agents, have not been benefited.

Radium, however, not only cures these lesions but does so with less deformity than operation. It will often save an eye that operation will not save. It has been used successfully in one of our cases after operation for removal of the growth had been demonstrated to have been incomplete by microscopical section.

Its use, therefore, becomes important after operation to prevent recurrence. Inasmuch, however, as its success after operation depends upon its power of destroying what the operation itself has left behind, it is unquestionably an error to operate on these cases rather than treat them primarily with radium as the method of choice in the treatment of epithelioma of the lids.

Quite aside from the danger that operation may not remove the whole growth, it increases the danger of recurrence by the trauma it inflicts and the risk of causing inflammation in the wound.

The efficiency of radium in the treatment of epithelioma of the lids frequently depends upon the basular cell character of these tumors and its success is best illustrated by referring briefly to a few illustrative cases.

These cases may be classified into three groups:

First. Those cases in which practically no destruction of the lids has been caused.

Second. Cases with definite or complete destruction of the lids. The lower lid is far more frequently involved.

Third. Those cases in which the disease has infiltrated the orbital conjunctiva to a degree necessitating removal of the eye.

Epitheliomas of the eyelid of the first and many of the second class are best treated by surface application. Such is made more accurately by making first a mold of the diseased area and surrounding tissue of dental modeling compound. The compound is warmed and thus softened. It is then placed over the

area mentioned and left to cool and harden. When hard it is removed and the diseased area is outlined upon it. The radium enclosed in *½mm* silver tubes, one to every sq. cm., is inserted in the mold, which is replaced and left over the growth long enough to administer 60*mc* hrs. per sq. cm.

Our own results have been confirmed by numerous reports in the literature.

Boussi reports eight cases of epithelioma of eyelids treated by radium and gives the bibliography from 1904 to 1913.

Poulard reports the cure of an advanced inoperable case.

De Lapersonne also reports favorable results on a number of cases, so also *Scoini*.

Del Mazo reports another cure. He used 90*mg* of armide daily, giving each time fifteen to twenty-two hours filtered through lead. Total dosage was 228 hrs.

Cavara reports sixteen cases cured by local applications of radium. No recurrences to date, but all recent.

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A CASE OF TRIGEMINAL NEURALGIA.[1]

By CHARLES W. STEVENS, A.M., M.D., New York.

NEURALGIA associated with the distribution of the fifth nerve, or tic douloureux as it is sometimes called, has long been found a fertile subject for discussion, conjecture, and experiment. It has been attributed to causes without number ranging from the rather indefinite "neuropathic tendency" to the much overworked dental complications of the present day. Yet it has been impossible in a large majority of cases to assign to it any definite pathology, and, unless other cranial nerves are involved, it has been difficult to differentiate between possible causes of a peripheral and those of a central origin.

A very significant statement is made by Dr. Edward W. Taylor in Osler's *System of Medicine*: "In the periphery a true primary neuritis of this nerve is exceedingly rare, and a neuritis secondary to disease in the neighborhood is also infrequent. Involvement of the nerve is naturally frequent in traumatism of various sorts, but it is rarely damaged in ordinary skull fracture. The pathological anatomy underlying the frequent neuralgia of the nerve is as yet wholly indefinite. Its association with arteriosclerosis, particularly in the neighborhood of the Gasserian ganglia, no doubt has some significance, but certainly in many cases is an insufficient and incomplete explanation of the pain. The studies of Spiller, Barker, Rusk, and Cushing have shown certain alterations in removed Gasserian ganglia, but not sufficiently characteristic to permit of their definite association with neuralgia."

[1] Presented before Section of Ophthalmology, New York Academy of Medicine, November, 1919.

Similar opinions as to the uncertain pathology of this malady have been expressed by other careful observers, and yet, even with this uncertainty, there has been a gradually increasing tendency towards methods for its relief which involve either decided impairment of function or absolute destruction of important nervous tissue. Of the various forms of injection employed only those which destroy portions of the nerve are considered successful. As to surgical methods, they are all aimed directly at an actual and permanent break in either the smaller or larger nerve channels; while the more radical of the operations commonly advocated, the removal of the Gasserian ganglion, brings as its sequence an absolute obliteration of one of the most important sensory areas of the body. In addition these various surgical experiments are almost invariably accompanied with irreparable, and often distressing, deformity of the face.

It would seem, therefore, that, if a reasonable explanation of the frequently encountered neuralgias of this nerve could be reached and a cause determined upon, the removal of which would in no way involve the unfortunate sequelæ of the methods mentioned, all of these destructive surgical experiments might well be abandoned.

In 1877 attention was called to the relationship between ocular defects and neuralgias of various types by Dr. George T. Stevens, who reported a number of cases, including several of trigeminal neuralgia, which were relieved by the proper correction of errors of refraction. Little was known at that time of ocular disturbances due to anomalous muscular adjustments, and no definite conclusion was reached as to the true relationship between the neuralgic pain and the eye defect.

Since that time, however, the researches of Dr. Stevens into the association of functional nervous diseases, and anomalous conditions of the ocular motor apparatus with their accompanying facial adjustments, have shed an abundance of light on many of these formerly obscure conditions.

A careful study of facial expression in its relation to ocular adjustments enables us to reach a logical and convincing explanation for many of the forms of idiopathic neuralgias, if they may be so called. This relationship is readily demonstrated in the neuralgias affecting the trigeminal nerve, and

especially so in those cases where the pain is associated with the first or ophthalmic branch of the nerve, which is the form most commonly encountered.

The report of a typical case, chosen from among many, will serve as the best means of showing this association.

The patient was a clergyman, twenty-nine years of age, who was in charge of an important parish in northern New York. He was brought to me on September 11, 1917, by Dr. Charles R. Payne of Wadhams, N. Y.

He stated that he had always suffered from migraine. In 1910 he first began to have periodic attacks of severe supraorbital pain. At first the attacks appeared at intervals of about six months, but gradually increased in severity and frequency and in 1917, at the time he first consulted me, they were recurring about every two months.

The pain started in the supraorbital region of the left side and would extend backwards to the parietal eminence of the same side and thence to the occipital region. It was generally accompanied with severe orbital pain. In character the pain was typical of the condition known as clavus hystericus—that is, a sensation similar to that of a hammer being driven into the skull at frequent intervals. The attacks of severe pain would last for a period of ten to twelve hours and would then be followed by lesser pain which would continue for a longer period. The points of Valleix, or tender spots, were present in the eyeball, over the supraorbital notch, and over the parietal eminence of the left side.

The pain was so severe that at times there was complete loss of consciousness, and for three years this loss of consciousness had frequently been followed by convulsive seizures of an epileptiform character. There was also present on numerous occasions a fugitive paralysis of the right arm.

The lapses of consciousness would last from a few minutes to several hours and on a number of occasions for two or three days. Severe mental disturbance often accompanied the attacks. The patient states that during one attack he ordered his wife out of the house and on another occasion he threatened his physician with a revolver.

Memory of the attack was sometimes completely lost. He describes one attack which was ushered in with headache and nausea coming on during his sermon at a Sunday morning service. He remembers conversing with some of his congregation on the steps of the church after service, but from that time has no recollection of anything that transpired until the following Tuesday morning.

He also stated that for years he had not had a normal appetite.

The patient had been under Dr. Payne's observation for a considerable period and he had been unable to find evidences of any lesion of an organic nature. The only way in which he had been able to alleviate the attacks was by the use of morphine which he had employed in doses as arge as ¾ of a grain, giving as much as two grains in twenty-four hours. Even with such doses it had required from twenty-four to thirty-six hours to control an attack. On one occasion morphine had been of no avail and he had employed hyoscine in full doses.

Other medical friends had strongly urged the removal of the Gasserian ganglion and this would have been done had it not been for Dr. Payne's insistence that the ocular conditions should be carefully investigated.

Examination of the eye conditions made on the day of the patient's arrival, and repeated on the next day, revealed the following facts:

Examination with the ophthalmoscope showed no lesion of the fundus of either eye. He had a refractive error which was corrected to Vision $\frac{6}{6}$ with Sph. + 0.75 D. combined with Cyl. + 0.75 D., axis 90°, in each eye and was wearing this correction. With the phorometer he showed an esophoria of 2° and no hyperphoria. The rotations were practically normal in all directions. With the clinoscope, however, a declination was found amounting to + 2° in the right eye and + 5° in the left eye.

While the instrumental findings in such cases are, of course, highly significant, it is of the utmost importance that careful observations should be made of the facial expression and of the bodily pose. The necessity for the maintenance of the eyes in an erect vertical position in the interest of clear vision is so insistent that, in cases of heterophoria and declination, the eye muscles alone are frequently, in fact almost invariably, found to be inadequate, and assistance is demanded from the more vigorous facial muscles. As a consequence there are certain well defined and characteristic facial adjustments which always accompany the different forms of heterophoria and declination.

In this particular case the habitual facial expression and carriage of the head were in a marked degree characteristic of the anomalous muscular conditions shown by the instrumental tests.

Both of the brows were strongly compressed, the left to a greater extent than the right. There was a deep depressed vertical ridge in the space between the two eyebrows. Well defined transverse wrinkles were prominent on the forehead,

and the integument appeared as if drawn forward and downward to the brows. The strong compression of the brows gave the eyes the appearance of being half closed. There was a constant spasmodic contraction of the whole face, more pronounced on the left side; in fact, the patient stated that at times this spasm was so intense that the eyelids became inverted.

This strong compression of the eyebrows is characteristic of esophoria, and its asymmetry is equally characteristic of a higher degree of declination on one side than on the other.

Assuming a close relationship between the neuralgic pains and the manifest ocular maladjustments, it was decided to remedy the latter as far as possible and in the period from September 13th to October 18th three operations were performed with the object in view of correcting the declination in both eyes. These operations were what are called extendo-contractions, in which the tendons of the recti muscles are severed from their attachments and then reattached to the eyeball in a position which will bring about an actual tilting of the vertical meridian of the eye, without in any way affecting the rotating ability of the muscles or inducing any heterophoric conditions. Such operations are attended with but slight temporary inconvenience to the patient. If properly performed, no perceptible trace of the operation will exist after a short period.

The patient then left for home and returned again in December with the report that there had been a decided improvement in all his symptoms. He had had no further severe attacks of neuralgia but there had been some slight headache. His appetite had become normal and he was eating three good meals a day. He was able to use his eyes and to read with no undue sense of strain or tension. There was also evident a decided change in his facial expression. Although there was still some compression of the left eyebrow, the appearance of spasm had practically disappeared and the lines of the forehead were scarcely noticeable.

Further examination revealed the fact that there was still about 2° of declination in the left eye and none in the right. A final operation was performed and when the patient left New York there was manifest only ½° of declination and ½° of esophoria.

Frequent reports of the case have reached me since that time and in October of the present year the patient called on me to report his condition.

In appearance his face was that of a person well at ease and there was no trace of the former strained and contracted expression. The forehead was smoothed out and there were no

prominent lines. He stated that there had been no return of the neuralgic attacks during the two years since the operations on his eyes. The headaches had also disappeared and he was able to use his eyes with perfect freedom.

He also stated that there had been a great change in his mental condition. Previous to the work on his eyes he had been unable to do effective writing, was unable to get any substance into his sermons, and could not concentrate his mind on a subject for any length of time. At present he is preaching good sermons, is writing for several theological magazines, has added another church to his parish and is successfully conducting the work in both of them. In addition he is doing much public work of a taxing nature without ill results.

In arriving at an explanation of the association between the neuralgic pain and the faulty ocular adjustments, I think we may well depart from the traditional form of attributing it to reflex action. In this case it is easy to trace a direct mechanical cause for the nervous irritation expressed by the neuralgia.

The frontal branch of the ophthalmic division of the fifth nerve leaves the orbit in two branches, the supratrochlear and supraorbital branches, which pass out of the orbit over its prominent superior border and, passing upward underneath the muscles and in close proximity to the bones of the cranium, are distributed to the muscles of the forehead, the corrugator supercilii, occipito-frontalis, and orbicularis palpebrarum. Branches are also distributed to the integument as far back as the occiput, and to the pericranium of the frontal and parietal bones.

The close proximity of these sensory nerve filaments to the unyielding bony structure over which they pass makes them exceedingly liable to irritation from any undue pressure; and when this pressure and tension are exerted over an extended period, it is natural to assume that the continued irritation will express itself as pain.

With these simple factors in mind we are in a position to formulate a reasonable explanation for the sequence of conditions leading up to the neuralgia.

The dominating factor in the whole sequence is the necessity for the maintenance of clear binocular vision, and the main obstacle to be overcome is the correction of the high degree of

declination. In the efforts of adjustment for this condition the muscles of the forehead are drawn forward and compressed over the brows, thus being kept in a constant condition of overtension, and bringing to bear a direct mechanical pressure on the nervous elements of the region. The pressure results in irritation of the nerves and the irritation is manifested as pain. It is also reasonable to suppose that this pressure will be greatest over prominent points; hence we have areas of greater irritation or tenderness over the orbital border and near the parietal eminence, thus explaining the points of Valleix, while the muscular pressure on the eyeball itself to maintain it in the vertical position would explain the pain in that organ.

The logical conclusion, therefore, is that, if the unnatural tension of the muscles and integument of the forehead can be relieved, the pressure on the nerves will cease and the pain will disappear. This certainly cannot be accomplished by any measures undertaken for the destruction or removal of the nerve channels as such measures fail utterly in modifying in the least degree the true cause of the disturbance. Further, more frequently than not, they are inefficient and their exceedingly undesirable accompaniments of loss of function and disfigurement do not recommend them. The only rational method of relieving this tension is by the correction of the declination, which is the real cause of the facial distortion. Surgical procedure properly carried out for such correction is attended with no undesirable consequences, and results as thoroughly satisfactory as were obtained in this case may be expected to follow.

A NEW APPARATUS FOR TESTING ACCOMMODATION.

By Captain HARVEY J. HOWARD, M.C., Medical Research Laboratory, Hazelhurst Field, Mineola, Long Island, N. Y.

(*With eight figures in the text.*)

OF all the eye tests performed by a number of examiners, the one producing results subject to the greatest variation is the test for the near point of accommodation. These discrepancies may be caused by any one or more of several different factors:

(1) Difference in the size of the test objects.

(2) Difference in the speed of approach of the test object.

(3) Difference in the illumination and legibility of the test letters.

(4) Difference in the place of contact and the angle of the measuring rule.

(5) Difference in the position from which the reading is computed.

(6) Difference in the instructions to the subject.

(7) Difference in the personal equation of the examiners.

(8) Difference in the personal equation of the subject, *e.g.*, the motive of the examination.

In the examination of applicants for the United States Aviation service a test for the near point of accommodation has been made in every case. A comparison of the data, however, must convince one of the utter unreliability of the figures recorded. In the first place, the test was made subjectively, *i.e.*, the applicant was required to indicate, while the test card was approaching his eye, the first blurring of a letter. When we recall that the applicants were all endeavoring to make as good

a showing as possible, it is easy to understand why many of the findings are absurdly small. Of all the factors referred to above as the cause of the great variation in the results obtained by medical examiners, the personal equation of the applicant is probably the most important. At the same time it is quite likely that all the other factors operated as well.

If the Air Medical Service is offered no alternative but to disregard the data on accommodation already recorded, it is also placed in the undeniable position either of discontinuing further tests or of devising a test which will give more consistent results. The importance of a good power of accommodation on the part of a flyer is so generally accepted that it seems unworthy to drop the matter summarily. The other alternative then must be accepted.

Our problem therefore is to devise a test which will both compel the adoption of a uniform method and produce objective results. The apparatus used at present consists of a Prince rule and a card of small letters or the Duane disk. Tests with this apparently should give very consistent and comparable results if carried out by one careful examiner under the same conditions. The apparatus is simple and inexpensive. Perhaps its chief fault is that, in being so simple it lends itself readily to very different and careless methods of use. From an ideal viewpoint an apparatus should be so constructed that it will automatically require a standard position in respect to the subject before a test can be accomplished. In the first place, it should not be required to be held in position by the examiner; it should either be set in a head-rest or held firmly in a fixed position by the subject. By such an arrangement several of the disturbing factors already mentioned would be eliminated. But as long as the test is applied subjectively, just so long will results still be inaccurate and incomparable when dealing with candidates required to pass a high standard. When dealing with office patients, the problem is an entirely different one. From them the examiner expects the fullest coöperation and generally receives it. Under such circumstances the approximation method, referred to below, should give consistent results if the other disturbing factors are eliminated.

If it is necessary to make the test objective, then letters or

figures must be used. Furthermore, the test card must first be held so close to the eye that the letters are unrecognizable, and then carried slowly away until they first become legible. This is called the recession or objective method. Unless the subject has learned the letters prior to the test, it must obviously be considered an objective result the moment he reads them correctly. The usual method of examination is to bring the test card slowly towards the eye and require the subject to state when the test object shows its first blurring. This is called the approach or approximation method, and gives subjective results. This brings up the question as to the comparison between results obtained by approximation and recession methods.

The approximation method calls for the location on the diopter measuring rule of the first blurring of a letter or object. If the card is gradually brought further in, the letters finally become illegible. The result accepted quite generally by this subjective method is not the point of the first illegibility but the point of the first blurring noticed.

The recession method requires the card to be held close to the eye at the beginning and carried slowly away until the letters become legible. The position on the rule where this first legibility occurs is not the same as the point of illegibility by the approximation method. But as a matter of fact, attested by a number of experiments, the point on the rule indicating the first legibility by the recession method is the same or practically the same point as that indicating the first blurring by the approximation method. The difference in the two was found to be astonishingly small—in some individuals less than 1*mm* of actual measurement. With these results before us, our problem is made easier.

The only other requirement is that the letters will be so arranged or manipulated that their order cannot previously be learned. To meet all the requirements indicated above, an apparatus to be described below was designed.

The apparatus consists of four essential parts:

1. A hood with an observation aperture for one eye.
2. A rule attached to the hood, measured off in millimeters and diopters.
3. A test object carrier.

4. A set of test letters and test objects.

The following is a description of the essential parts in detail:

1. The hood (Figs. 1 and 2) is a combination of two three-quarter face masks. The cut out in the left half is for the nose when the right eye is looking at the test objects through the circular opening; the cut out in the right half is for the nose when the left eye is looking through the circular opening in the center of the hood. The hood is made of aluminum and of

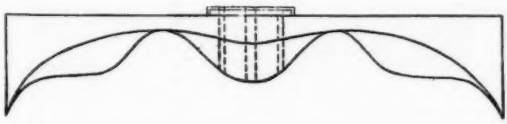

FIG. 1. View of the hood in cross section from above.

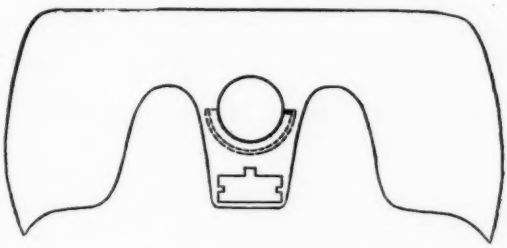

FIG. 2. View of the hood from behind as the subject sees it.

sufficient size for the largest face. In front of the aperture is a slot for holding lenses. Figure 1 represents the shape of the hood as one looks at it from above. Figure 2 represents the shape and appearance of the hood looked at from behind, *i.e.*, as the subject views it prior to adjusting it to his face. From these figures it is noticed that there is a bulging of the mask in the middle section below the circular opening. Into this section is set the measuring rule. This bulge is so formed that when the mask is adjusted to the face, and the rule is held in a horizontal position in respect to the vertical position of the head, it fits snugly against the malar bone which forms the lower anterior part of the orbit.

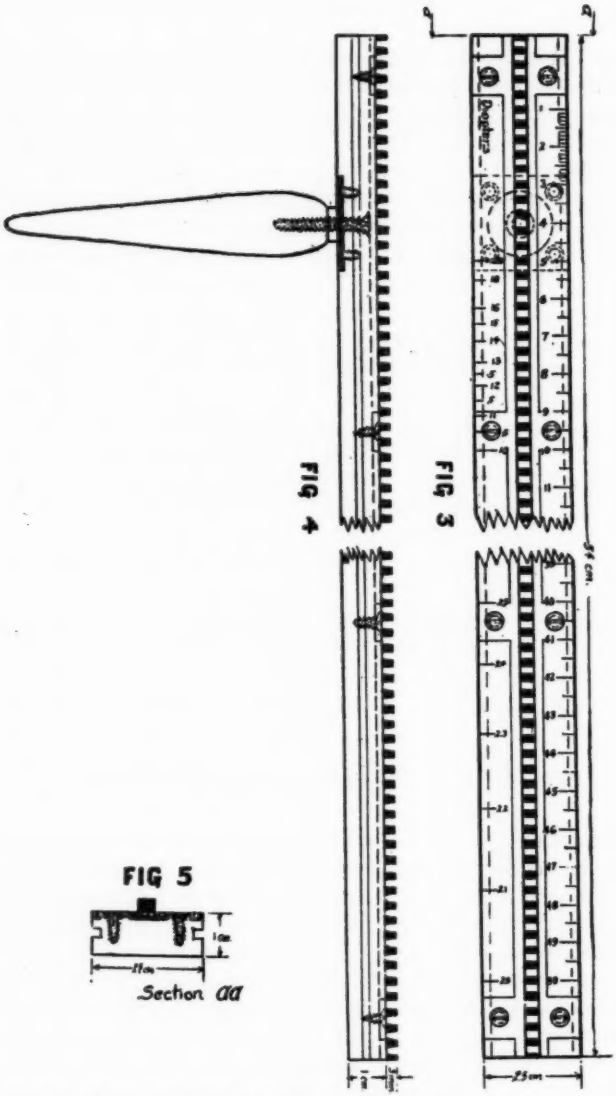

FIG. 3. The rule divided into millimeters and diopters.
FIG. 4. The rule showing handle and rack.
FIG. 5. Cross section of the rule.

2. The measuring rule (Figs. 3, 4, and 5), is made of wood and is 2.5*cm* wide and a little more than 50*cm* long. One end is set into the hood (Fig. 2) so that its median line is exactly beneath the center of the aperture. The left side of the rule (Fig. 3) is marked off in centimeters and millimeters. Zero on this scale is 17.5*mm* from the end of the rule where it butts against the malar bone. From a series of measurements on a number of individuals, it was found that the average distance

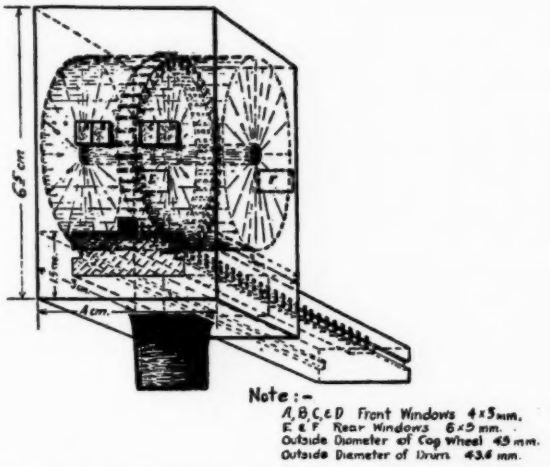
6.5 cm
1 cm.
Note :-
A, B, C, & D Front Windows 4×5 mm.
E & F Rear Windows 6×9 mm.
Outside Diameter of Cog Wheel 49 mm.
Outside Diameter of Drum 43.6 mm.

FIG. 6. Test object carrier showing drum which carries the test letters.

from the malar bone, at a point directly below the pupil of the eye to a perpendicular line drawn tangent to the cornea was 6*mm*. Inasmuch as all measurements of accommodation should be made from the anterior focus which is 11.5*mm* in front of the cornea, zero on the scale must be located 17.5*mm* in front of the facial end of the rule.

The right side of the rule (Fig. 3) is marked off in diopters and fifths of diopters so that the decimal system may be used. Extending the length of the rule (except for the first 4 or 5*cm* of the facial end), on its upper surface and located in a median line is a rack composed of metal cogs about 3*mm* high. Attached to the lower side of the rule, 4 or 5*cm* from the facial

end, is a handle. In place of the handle there may be substituted a steel rod which can be fastened to a table clamp in case it is found desirable to make the apparatus stationary, as a head rest.

3. The test object carrier (Fig. 6) consists of a box of light metal containing a metal barrel which rotates about a central axis. The barrel is divided into two equal parts, left and right, by a circular rack of cogs, which coincide with those of the rule. Attached to the box beneath is a flat holder to be grasped by

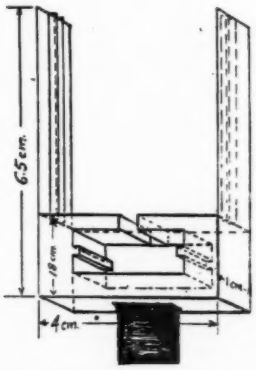

FIG. 7. Accessory test object carrier.

the thumb and forefinger. By this means the box may be propelled back and forth along the rule and the barrel made to rotate. The box may be propelled either by the subject or by the examiner. In the front partition of the box at its horizontal center are two small double windows lettered A, B, C, and D, in Fig. 6. By the addition of a metal slide only one of these windows may be open at one time. In the back partition of the box are also two windows. As the barrel rotates, letters or other test objects appear in succession before these windows. The windows in front permit test objects to be viewed by the subject when he looks through the aperture in the hood. The windows behind are made for the examiner who sees letters or test objects in the same series as the subject sees them. Figure 7 represents an ordinary test object carrier which may be used when the Figure 6 carrier is not required. A Duane accom-

modation disk or any card of small test letters may be carried in this holder and the usual subjective test applied. The slot for carrying the test card should be flush with the front edge of the carrier so that the reading on the diopter scale may be facilitated.

4. The test letters and test objects are represented diagrammatically in Figure 8. The test objects are engraved on heavy white cardboard in two sizes. B and C which appear before windows B and C, Fig. 6, are 0.8*mm* high and A and D which appear before windows A and D are 1.2*mm* high. The actual length of the card is 140*mm*. In each row there are forty letters or objects which recur every 3.5*mm*. Rows E and F which are only diagrammatically shown in the figure are made as large as possible. They appear to the examiner at the windows E and F of the box. The opportunity is given to use either letters or the conventional E. The primary object of the letters thus arranged is to employ them as an objective test. The test carrier therefore must be started as close to the eye as possible and pushed slowly away until the subject is first able to read a letter or distinguish correctly the position of an E. The examiner who stands so that he can see the objects appearing at one of the windows in the back of the box is able

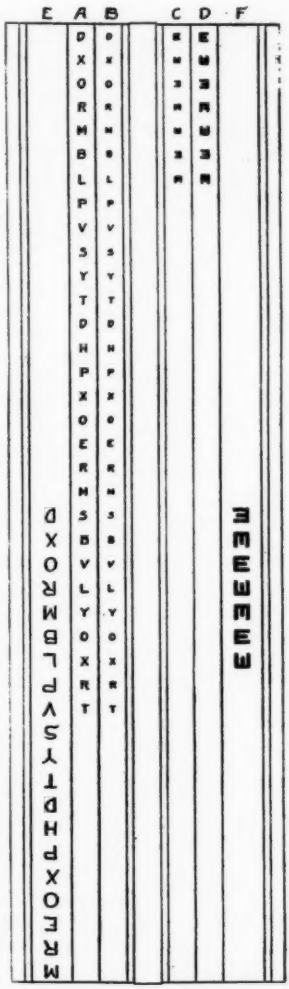

FIG. 8. Diagrammatic representation of the test letters and test objects.

to verify the statements of the subject because the letters or objects which each of them sees, occur in the same series. To the subject the test objects go up behind the window while to the examiner the test objects come down. If more than one reading is desired, the test carrier may be pulled off the rule and set back again in a different position, so that at the same distances from the subject's eye, different letters will appear from those previously seen.

THE PUPILLARY SYMPTOMS IN A CASE OF EMBOLUS OF THE CENTRAL ARTERY OF THE RETINA—WITH ESPECIAL REFERENCE TO THE PRIMARY REFLEX.

By JOHN DUNN, M.D., Richmond, Va.

Early in June, 1919, Mr. A., aged 36, became suddenly blind in his left eye. When seen a few days later the fundus presented the following picture. The retinal arteries were threadlike; the veins were much reduced in size; the nerve head was white; the well-known cherry spot occupied the region of the macula; everywhere, save for the exception noted below, the retina had lost its clear pinkish color, this being replaced by a cloudy white, indicative of the œdema present. This whitish hue was most marked above and below the disk and about the macula. Extending from the outer margin of the disk nearly to the cherry spot was *a tonguelike projection of normally pink retina.* Vision was abolished, except for an area which corresponded to this pinkish projection, the patient explaining that he could "see to the outer side of anything" he "tried to look at." *There was no direct response of the pupil to light;* the pupil, however, responded normally both in accommodation and consensually. The left pupil dilated more when the right eye was excluded from the light than the right pupil did when the left eye was excluded. The excess dilatation of the left pupil was, however, only moderate in degree. The normal pink of the tonguelike projection from the disk was probably due to the fact that this area obtained its nourishment from a cilio-retinal vessel. This vessel, however, was not visible to the ophthalmoscope. One month later the picture had changed. The disk now showed the white of extensive atrophy. The arteries were now threadlike. The veins were very much contracted. The cherry spot had disappeared, as had also the œdema and the pinkish contrast of the tonguelike projection. The fundus had returned, as far as my eye could see, to its normal color.

Vision was no better than when the eye had been examined a month before. ***The direct response of the pupil to light had returned.*** The embolus of the central artery of the retina came from a cardiac lesion.

The case has two points of interest: I. The retention of the normal pinkish color of the retina in the tonguelike projection above described. The explanation for this has been given. Its interest is slight and is due to its rarity. II. ***The absence of direct response of the pupil to light while the œdema was present and its return after the œdema had disappeared.*** If the direct, *i.e.*, the primary, response of the pupil to light is the result of impressions which pass along the retina to the midbrain, then it should have been absent or present under both conditions. On the occasion of Mr. A.'s first visit the portion of the retina supplied by the cilio-retinal artery was functioning, as was shown by the patient's ability to see light and the details of objects and yet the direct response to light was absent. A month later there existed the same amount of vision, and no more, and yet the direct response to light was present. I can see but one explanation for this. On the occasion of Mr. A.'s first visit the œdema of the retina prevented the action of light on the retinal pigment cells. At the time of his second visit this œdema had disappeared and the pigment layer which does not derive its nourishment from the retinal vessels could be acted upon by the light—hence the presence of the primary pupillary response to light.

In more than one contribution to the ARCHIVES OF OPHTHALMOLOGY I have tried to prove that the direct response of the pupil to light is a primary reflex and is accomplished without recourse to the optic nerve and intracranial pupillary pathways so long as these are intact; that the primary pupillary response to light is an extracerebral reflex and that its nervous pathways are as follows: retinal cells to retinal pigment cells, along this pigment layer to the ciliary region where sensory impulses are aroused in the sensory nerves to the ciliary ganglion from this region, thence along these ciliary sensory nerves to the ciliary ganglion in the substance of which impulses are aroused in the motor cells of the ganglion which impulses passing outwards result in contraction of the pupil. In no other way can I see a possible explanation of the phenomena of the Argyll-Robert-

son pupil, of the behavior of the pupil in the second stage of ether anæsthesia, of the pupillary phenomena which just precede death, etc. This conception of the primary response of the pupil to light is of the first importance. Without it, as I see it, the pupillary phenomena in health and in disease will continue, as they always have been, unintelligible. In the case here reported, it is probable that all of the retinal cells except those in the area nourished by the cilio-retinal vessel have atrophied and the light stimulus to the pigment layer is received only from impressions made upon this cilio-retinal region. Inasmuch as the primary response of the pupil to light is within limits proportionate to the amount of light stimulus to the pigment layer, we have in the case of Mr. A. a weaker contraction of the left pupil than of the right to the same degree of illumination.

THE MADDOX MULTIPLE RED ROD: A CONSIDERATION OF SOME OF ITS OPTICAL DEFECTS.

By Captain PERCIVAL DOLMAN, M.C., Medical Research Laboratory, Hazelhurst Field, Mineola, Long Island, New York.

DURING the course of a series of experiments made for the purpose of investigating the accuracy of the Maddox rod test, it was discovered that the line of light often appears nearer than the light which is located six meters away. The statements of a number of observers have repeatedly verified this fact.

When the line is in sharp focus, it is seen as a bright band of light, of uniform density, with sharp, clean-cut edges. Such a line appears to be located at the same distance as the light. When the line is not in focus, it is seen as a wider band, of unequal brightness, with hazy, irregular edges. The general effect is that of indistinctness. The line then appears to be located often only a few feet from the eye.

The influence on the Maddox rod test of this false localization of the line is in favor of the measurement of an excessive amount of esophoria.[1] The appearance of the line of light, therefore, has a direct bearing on the accuracy of the test.

The same indistinct appearance of the line may be caused by certain optical defects in the Maddox rod. An examination of the several rods which were being used at the time, disclosed such a high percentage of defects that a special investigation was begun to determine the optical qualities of other Maddox rods in general use. The results of that investigation form a part of this report.

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[1] Dolman, Perc., "The Maddox Rod Screen Test." Archives of Ophthalmology, September, 1919.

Twenty multiple red rods were examined. Some of them were in use in the laboratory, others were found in nearby clinics, and a few were obtained from dealer's stock. The defects found in these rods are of two types, involving (1) the character of the line of light and (2) the presence of prism acting to deflect the line of light from its true position.

The prism is readily detected by holding the rod before one eye so that a horizontal line of light is seen while the other eye looks at the light. The position of the line in relation to the light is observed. Then the rod is rotated through 180 degrees just as a cylinder is rotated in the trial-frame. The line is again horizontal and, if no prism is present, will be in exactly the same position in relation to the light as at the first observation.

The following table summarizes the data obtained from an inspection of these rods. No prism, less in amount than one half prism diopter, is recorded.

INSPECTION OF MADDOX MULTIPLE RED RODS.

No.	*Character of Line.*	*Amount of Prism Deflecting Line.*
1	Good	½ +
2	Indistinct	½
3	Good	None
4	Indistinct	½
5	Good	None
6	Indistinct	½ +
7	Indistinct	1
8	Good	None
9	Good	½
10	Indistinct	None
11	Indistinct	None
12	Good	½
13	Indistinct	½ +
14	Indistinct	None
15	Indistinct	1
16	Good	½
17	Good	None
18	Indistinct	½ +
19	Good	None
20	Good	None

It will be seen by reference to the table that ten multiple red rods (50%) formed a line of light defective in character and apt for this reason to give an inaccurate result in the test. Eleven rods (55%) contained an amount of prism ranging

from one half to one prism diopter. Six rods (30%) were found to be free from all defects.

Ten single, clear glass rods were inspected and all but one found to form a line of light of acceptable character. The one exception formed an indistinct line, variable in width and of unequal density. No prism deflecting the line was found in any of these single rods.

An inquiry into the manufacture of multiple red rods was made for the purpose of learning why the product shows such a high percentage of defects. The various steps in the process are so little known outside the trade that the facts are briefly presented here.

Multiple red rods are manufactured from "ruby cane" which is supplied by the glass factory in strips eighteen to twenty-four inches long, ⅜ of an inch wide and about ¼ of an inch thick. The strips are made by a process of drawing and pressing which forms the well-known corrugations on one side and leaves the other flat. Red pot-glass is not used in making "ruby cane" because the variable thickness of the glass due to the corrugations would give a line of light of uneven red color. The glass factory has solved the problem by making "ruby cane" of clear glass which is flashed on the corrugated side. By this process the corrugations are covered with a thin film of red glass which gives the line of light a nearly uniform red color.

Pieces cut from the strips are optically ground and polished on the flat side and edged to size before being mounted. The corrugated side of the rod cannot be polished or finished in any way without removing the thin flashing from the high points, thus destroying the uniform color of the line of light. For this reason, all surface imperfections, resulting from the crude drawing and pressing processes, are allowed to remain on the corrugated side of the finished Maddox rod. It is to these imperfections chiefly that the defective character of the line of light is due.

The prism that is found in so many rods of this type is a result of imperfect workmanship during the process of finishing the flat side. The pieces of "ruby cane" are mounted with hot pitch, corrugated surface downward, on a stock or holder and then ground and polished on the flat side. If the corru-

gated side is not mounted in proper contact with the stock, the rod when finished will contain some prism.

The accuracy of the Maddox rod test is affected by the prism only when its base is so located that the line of light is deflected at a right angle to its direction.

The manufacture of multiple red rods involves several highly technical processes and the finished product is probably as good as can be expected. It should be possible to supply them free from any prism but the removal of optical defects from the corrugated surface is a problem that will not be easily solved. Some of the responsibility for the condition exposed in this report may be shifted to the popular demand for a colored multiple rod. The test can be accurately made with a clear glass multiple rod and a colored glass may be used with it if a colored line of light is desired.

Clear glass multiple rods are being manufactured from optical glass blanks, with the corrugations cut by a lap instead of being shaped by pressing and drawing. These rods are free from prism and form a line of light that cannot be criticized. They offer the best solution of the problem under discussion.

THE REMOVAL OF MAGNETIC FOREIGN BODIES FROM THE VITREOUS.[1]

By LEE MASTEN FRANCIS, M.D., Buffalo.

THE purpose of this paper is to formulate, if possible, some definite plan by which one may be guided in selecting a method and route in the extraction of magnetic foreign bodies from the vitreous and to set forth the intimate technique of the procedure, and in so doing bring out certain details not usually considered or assumed as being understood. It is not claimed that any of this is new or original, but in as much as surgical perfection is approached by the improvement of details, it is hoped that some of the steps may be helpful to others; but more especially that the presentation of this subject will stimulate a discussion, which will bring to the surface improvements in method which individual experience has proven useful.

It is assumed that the penetrating body has not carried with it infection and the discussion deals with eyeballs, which are in a fair way to be saved after the removal of the foreign substance.

Diagnosis.—Experience has repeatedly shown that the absence of a visible avenue of entrance is a thoroughly unreliable guide in the diagnosis of the presence of a foreign body in the globe, or if present, does the apparent path through the media, furnish reliable information as to its ultimate location, unless, of course, the body is plainly visible to the ophthalmoscope. In a similar way, the history is totally to be disregarded. I depreciate the use of the giant magnet as a means of diagnosis. The exposure of an eyeball to the giant magnet without previous knowledge as to the size, location, and posi-

[1] Read at meeting of American Academy of Ophthalmology and Oto-Laryngology, Cleveland, October, 1919.

tion of the entering body, may do infinite and irreparable harm. Enough information cannot be gained to warrant the practice.

The final diagnosis must rest with the Roentgenologist and to the Roentgenologist the suspected case should be sent promptly. How many exposures should be made? There is no set number, but enough to establish, not only the definite localization of the particle, but what is of equal importance, its several dimensions. It is quite obvious that photographs exposed in two planes only (as is usually done), cannot provide this information—always three and sometimes four are needed. Too much emphasis cannot be placed upon the necessity of knowing the three dimensions, for upon this knowledge must rest the rational selection of the method and route to be chosen for its extraction.

Route and Method.—In the selection of the route and method of extraction, the surgeon should be governed solely by the location, shape, and size of the foreign body.

It is obviously very difficult to lay down didactic rules for the selection of the best route and method for all cases. However, a rational may be indicated. That method and route should be selected, which shall produce the minimum of damage to essential ocular structures, and likely be most free from deleterious aftermath. If the invading body is small, roundish, and presents no ragged edges, which may become entangled in the wound or ciliary structures in processes of delivery, the anterior route by means of the giant magnet presents the least surgical risk. If, on the other hand, the foreign body is rectangular, though smooth, and too long to pass through the suspensary ligament, posterior chamber, and pupil, the scleral route is the one offering least risk. If the foreign body though small, presents ragged, irregular notches and facets which are likely to entangle and damage the structures through which it must pass to effect delivery, here again, the posterior route is the one of election.

Location.—Whatever the size and shape of the foreign body, if lying against the ciliary body in such a position that there is likelihood of its becoming impacted in the ciliary body upon exposure to the tractive force of a powerful magnet, this fact alone should urge the selection of the posterior route.

To Summarize.—The posterior route is preferable as offering the minimum of risk in all cases except those of small smooth foreign bodies not lying against the ciliary body.

OPERATIVE PROCEDURE.

General Considerations.—The patient should be prepared as for any major ocular surgical operation. This includes trimming of the eyelashes and wrapping the head in a sterile covering, preferably moist to prevent slipping. Both magnets should be covered with sterile jackets. For the giant magnet, a pillow slip with one corner cut out does well enough. This permits the operator to tilt and direct the magnet. A towel suffices for the hand magnet. These coverings should be secured by safety pins or tapes. The various magnet tips should be boiled or effectively sterilized. The magnets should be provided with a rheostat switch directly under the operator's control.

Instruments.—A non-magnetic speculum is essential for both routes and for the posterior route two non-magnetic forceps and two non-magnetic mosquito hæmostats are necessary. Nothing is more awkward or disconcerting than to have the instruments fly to the magnet when the current is turned on.

Illumination.—Good light is essential. Artificial light, owing to the ease of its control is best—some type of hand lamp so hooded as to illuminate the operative field and not dazzle the operator's eyes and in the hands of an intelligent nurse, is ideal.

Anterior Route.—Giant and hand magnets.

The pupil, having been dilated to its maximum and the eye cocainized, the patient is placed on a stool before the magnet. I prefer to sit facing patient as being the more comfortable position in which to manipulate and observe. Either the magnet is tilted or the patient's head is turned so as to cause traction in the line indicated by the radiograph. The patient is slowly brought nearer the magnet. As soon as the foreign body has passed through the suspensory ligament and its presence in the posterior chamber is evidenced by the bulging of the iris, the direction of magnetic pull must be immediately changed to one of obliquity so as to attract the fragment through the pupil. Continued exposure in the first position may impact the metal

in the iris. When the foreign body has passed into the anterior chamber, the patient is removed to the operating table to complete the extraction by means of the hand magnet. By means of this magnet, the fragment is attracted to the upper quadrant of the anterior chamber near the contemplated incision. It is a mistake to draw the foreign body deep into the angle, out of sight, but it should be left near the base of the iris where plainly seen. From now on, it should be the chief aim of the surgeon to preserve the *aqueous as long as possible*. The anterior chamber is now opened with a keratome, promptly and in such a way as not to drain the aqueous. The keratome incision should not be at the level of the iris root but well above it, and directed nearly perpendicularly through the cornea in the direction of the fragment. The magnet tip is then applied to and not introduced into the wound. The assistant stands with the scissors ready to clip the iris should it through some mishap present. If the aqueous has been preserved, the fragment will glide promptly to the incision, where it can be delivered by the assistance of a fine forceps should the magnetic force be insufficient.

Posterior or Scleral Route with Hand Magnet.—The patient is placed on the operating table after the usual preparation made for any operation. The magnet is within ready access when needed. In addition to the usual anæsthesia obtained by the instillation of cocaine, a subconjunctival injection of a 1% cocaine and adrenalin solution is made at the site of the contemplated scleral opening. This insures not only good anæsthesia but a bloodless field. This incision should be planned to be made as near the foreign body as practicable, bearing in mind the avoidance of the ciliary body, and the insertions of the recti muscles, and in the lower quadrants rather than the upper. The bleb raised by the hypodermic is now seized with the forceps and a deep cut made in an antero-posterior direction with a bold stroke of the scissors. This cut includes conjunctiva, and subconjunctival tissue, exposing the sclera. The two flaps are now undermined for ten or more millimeters in either direction. A double-armed suture is now placed in the center of either flap incorporating a firm anchorage. These sutures are now secured by mosquito hæmostats and are used as retractors. The sclera is sponged free from hemorrhage and an

incision is made through the sclera with a sharp, well-pointed von Graefe knife. The incision should be adequate for the delivery of the foreign body and in the direction of the retinal vessels, antero-posterior. The magnet is then presented to the wound. Meantime, the assistant stands ready with the scissors to trim away the choroid should it present. Upon the delivery of the foreign body, the wound is promptly closed by tucking one flap under the other and covering the first by the remaining flap, in such a way as to utilize the flaps as tractors approximating the lips of the scleral wound; and at the same time seal and reinforce the wound by a double layer of conjunctiva. This flap was described by me in 1913 in a paper before the Section on Ophthalmology, American Medical Association.

A further word concerning the conjunctival flap as described above. An important step in the technique is the provision made for closing the wound before making the scleral incision. This minimizes the danger of prolapse of vitreous through unnecessary manipulation with an open vitreous wound. In addition to this, the flaps furnish splendid retractors, making the exposure of the scleral wound sure and certain without the necessity of retraction of the conjunctiva by forceps, thereby cluttering up an operative field already too small. In many instances when not able to have trained assistants, I have allowed the weight of the hæmostats to retract the wound lips. With this in mind, it is well to have the threads long enough to permit the hæmostats to hang over the patient's face.

These wounds, in my experience, heal kindly and promptly. I have never seen a gaping scar or bulging cicatrix.

The after care of these patients requires no especial comment. As a routine, they are given sodium salicylate, forty grains daily, for a few days. The sutures are removed in six to eight days.

CONCLUSION.

Unreliability of Case Reports and Statistics.—One naturally turns to reported cases and statistics in seeking guidance for the selection of a satisfactory method for the removal of foreign bodies from the globe. I voice my personal opinion upon the value of such data by saying that they seem quite unreliable unless collaborated from cases which are similar in essential

respects as to size, shape, and position of the foreign bodies and also to the amount of damage done upon entering the globe and the reaction they excite. The choice of an operative route seems more rationally to rest upon the selection of a method which will produce the smallest surgical trauma and do the least damage to essential structures. This, in turn, must depend, not upon a fixed procedure, but a procedure best adapted to the case in hand. I cannot be convinced that it is wisdom to drag an irregularly shaped, ragged piece of steel around the lens and through the pupil, and, on the other hand, I believe there is a minimum of risk involved by using this route for a small smooth fragment.

The purpose of this paper has been well served, if it has succeeded in pointing out some of the more essential points of technique, not frequently referred to, and has insisted that a given case should be weighed and estimated before the selection of an operative route or method.

REMARKS ON DIAGNOSIS AND TREATMENT OF LUETIC INVOLVEMENT OF THE OPTIC PATHWAYS.[1]

By MARK J. SCHOENBERG, M.D., New York.

INTRODUCTION.

I SHALL build my discussion on the subject of this paper around the following truisms:

(1) *The success of a treatment depends on* (*a*) *how accurately and early we make a diagnosis*, (*b*) *how well we know how to treat, and* (*c*) *how thoroughly the patient carries out instructions.*

(2) *Treatment will never equal prevention.* The second part of this paper reports on personal successes and failures in a series of cases of luetic involvement of the optic pathways.

I. EARLY DIAGNOSIS.

The subject of diagnosis of a disease of the optic pathways has progressed at a rate always in direct proportion with discoveries of new methods of examination of the visual apparatus. Our present means of establishing a diagnosis, though far from having reached a degree of ideal precision, constitute a pretty good armamentarium to furnish us more or less satisfactory information for an early diagnosis. And, yet, *early diagnosis of syphilis of the optic pathways is not made except in an infinitesimal percentage of cases.* Since the advent of the new era of scientific syphilography based upon the discovery of the spirochæta pallida, the routine examinations of the blood and spinal fluid and inoculations in animals, a number of facts of great importance to the clinician have been established.

[1] Thesis for American Ophthalmological Society, 1919.

One is that *the entire organism is invaded by the spirochætæ already during the secondary stage of lues.* Another fact is that about *20 to 25 per cent. of syphilitics show evidence of an involvement of the central nervous system during the early stages of infection.* A third fact is that *syphilis active or latent is present in a large proportion of the human race.*

Having learned this lesson, ophthalmologists necessarily will have to ask themselves: How frequently and how early are the cranial nerves, concerning directly or indirectly our own specialty, involved by syphilis? How early should we attempt to detect this involvement? It is not necessary to argue on the importance of these questions. The very heart of ophthalmology is involved in them. Taking only one phase of the subject, the second cranial nerve, we are not prepared to answer to-day with any degree of accuracy how frequently and how early it is involved in syphilis. Studies on this question, made in the era preceding the new discoveries in syphilography, are only partially reliable, because the means of diagnosis of syphilis were insufficient. Nowadays, when we possess the means of demonstrating the presence of spirochætæ in the lesion and when we can make use of the five laboratory reactions, (blood Wassermann, spinal fluid Wassermann, cell count, Lange, and globulin) in addition to the old clinical examination, our diagnosis is more reliable and the answer to the above questions may be considered nearer to the truth.

How early should we attempt to detect an involvement of the second cranial nerve in a luetic? *As early as the primary lesion makes its appearance; and the examinations should be repeated at regular intervals during the entire time the patient is under the observation of the physician.* If this attitude would be taken by ophthalmologists a number of important changes would take place. In the first place we would obtain definite data regarding the earliest period and frequency of appearance, the types of optic nerve lesions, their course, prognosis, and types of response to treatment in patients diagnosticated as syphilitic *by our present methods.* In the second place we would do our share to stimulate the general practitioner and the syphilographers to watch the cranial nerves and particularly the second nerve from the very beginning of the infection (a thing which with very rare exceptions is not done).

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In the third place we would gain valuable information regarding the future of the nervous system of that particular individual and we would be able to tell when to stop medication or to proceed with a new line of treatment. In the fourth place *it will prevent blindness.*

The conception of the words "early diagnosis" of syphilitic involvement of the visual pathways, as it was meant in the pre-scientific era of syphilography, was necessarily different than that we have to-day. Then, it meant the detection of fundus, perimetric, and other disturbances, as soon as the patient had some complaint about his vision, usually years after the infection had taken place. Now, it means *the search* (beginning already in the early secondary stage of lues) for symptoms and changes, possibly too slight to be noticed by the average patient. Then, the "early diagnosis" was in reality a "too late" diagnosis of very little practical importance, because the process was old and the changes advanced; now the early diagnosis is of great practical importance, because the process is searched and may be discovered at its inception when the changes may not be irremediable.

II. ACCURACY OF DIAGNOSIS.

There is no limit to the number of pitfalls we are exposed to, when we are called upon to make a diagnosis of a lesion of the optic pathways of syphilitic nature. *The first and most dangerous of all is the Wassermann blood test.* It has almost become an established tradition that a patient with, say, an optic neuritis or optic atrophy, and a 3 or 4 plus Wassermann blood reaction, must have a syphilitic optic nerve lesion. Nothing may be further from the truth than this, because: 1. One single blood test, made by one laboratory, can never be depended upon for a final decision. 2. The condition may be due to an entirely other cause than syphilis, although the patient may be syphilitic. 3. The condition may be due to syphilis plus one or several other causes. *One of the most difficult problems in medicine, and especially in ophthalmology and neurology, is the diagnosis of a non-syphilitic condition in a patient with syphilis.* From the therapeutic point of view the accuracy of the diagnosis may spell complete failure or success. The re-

ports of the following two cases will suffice to make this point clear.

The first case is that published by Dr. A. Knapp (ARCHIVES OF OPHTHALMOLOGY, January, 1918). A patient thirty-six years of age, luetic with 4 plus Wassermann and bilateral partial optic atrophy, with vision progressively failing in spite of antisyphilitic treatment. Later on, X-ray of the skull reveals a bone absorption in the sella turcica and anterior fossa, suggesting the presence of a mass lying in the sellar region, partly in the anterior, partly in the middle fossa. The patient died after an exploratory operation and at postmortem was found a large epithelioma in the frontal lobe springing from the dura on the convexity and from the adjoining part of the falx.

My own case, a man fifty-four years of age, had been infected with lues in 1904 and began to notice failing vision in 1915. Blood Wassermann 4 plus; the diagnosis of progressive bilateral optic atrophy of luetic nature was made by one of the most distinguished ophthalmologists of this country and abroad and in spite of a careful and sustained antiluetic treatment vision continued to fail. When the patient came under my observation in June, 1917, he had a bilateral absolute central scotoma, vision right $\frac{1}{100}$, left $\frac{1}{10}$ with correction. A careful inquiry brought out a ***history of excessive drinking and smoking.*** The discontinuance of this abuse and the routine treatment with K. I. strychnin and hot baths improved vision to right $\frac{20}{100}$, left $\frac{20}{10}$, and reduced the large, absolute central scotoma in the right to a small, relative paracentral scotoma, which enabled him again to read with ease ordinary newspaper type. This case illustrates how easily a syphilitic patient may be condemned to antileutic treatment if he has a 4 plus Wassermann blood reaction. Here we had to deal with a toxic amblyopia (plus syphilis) which naturally did not yield to antiluetic treatment only.

A great stumbling block in the path of accurate diagnosis is the presence of another disease besides syphilis. In such cases the question immediately arises: "Is the visual lesion due to syphilis alone, to this other disease alone, or to both together?" A schematic summary of conditions, to be investigated as I desire to keep before my mind, is as follows:

First: ***Acute or chronic sepsis*** (from foci of infection in nasal

sinuses, tonsils, ears, teeth, gall bladder, appendix, genitals, intestines, etc.).

Second: Acute or chronic toxæmias (disturbances of digestion, nutrition, and of elimination, of the endochrine system, lead, arsenic, alcohol, etc.)

Third: Acute or chronic trauma (emotional or physical, occupational; like aneurysms, empyema of nasal sinuses, periostitis of optic foramen, etc.)

Fourth: Heredity and congenital conditions. Only after having exhausted this sort of schematic plan of investigation (which is by no means an ideal one, as far as completeness is concerned) are we justified to say that the optic lesion, we are dealing with, is of purely syphilitic, of mixed, or of non-syphilitic nature. No matter how complex and almost hopelessly difficult such a search of the human organism appears to be, it cannot be denied that there is no other way of reaching an accurate diagnosis.

Leaving to the internist and other special workers the endless amount of clinical and laboratory work necessary for the elucidation of such a diagnosis, we should not be backward in adopting, as our own, new methods of examinations which contribute towards accuracy of diagnosis in ophthalmology.

THE SPINAL FLUID.

One of the most valuable additions to our diagnostic armamentarium of late years is the examination of the spinal fluid. The information furnished by this examination cannot be obtained in any other way. It has been definitely shown that the central nervous system is invaded very early at the beginning of the secondary stage of lues. Fordyce found that 20 to 25 per cent. of syphilitics show pathological changes of their spinal fluid during the first year of infection. H. Swift thinks that 33 per cent.; Ravaut that 67 per cent.; Gennerich even that 90 per cent. of syphilitics show changes of their spinal fluid during the early stage. The most characteristic evidence of the luetic invasion of the central nervous system is found in the examination of the spinal fluid. There are patients who have for years marked syphilitic changes of the spinal fluid and no clinical symptoms whatsoever. B. C. Corbus has seen

six cases of primary lues, 33 per cent. of cases with secondary lues, and 40 per cent. of cases with tertiary lues with no neurological symptoms, but with very marked luetic changes of the spinal fluid. It is a frequent occurrence to find luetics with negative blood Wassermann and positive spinal fluid findings. Consequently, since the spinal fluid may show evidence of lues, not discoverable clinically or by blood examinations, since it shows changes during the earliest as well as in all stages of neuro-syphilis, even before the symptoms of neuro-lues make their appearance, we have to utilize the spinal puncture in every case of lues with manifestations in the central nervous system or cranial nerves.

The information we receive is definite:

(1) It shows us whether we deal with a luetic involvement of the central nervous system (negative spinal fluid in a non-treated patient is a strong evidence against it).

(2) It gives a clue as to about what pathological type of lesion of the optic path we are dealing with. The marked pleocytosis, the reducible plus Wassermann, and luetic Lange point to a meningitic process; the ***non reducible*** plus Wassermann fast, paretic Lange, absence of marked pleocytosis, and marked globulin increase to a parenchymatous process.

(3) It furnishes us a good deal of information about the prognosis, the parenchymatous type being very much more unfavorable than the meningitic or interstitial type.

REMARKS ON PROPHYLAXIS AND TREATMENT.

A few years ago prophylaxis of luetic involvement of the optic pathways meant only one thing: ***avoiding the infection***. Now, since the early diagnosis of lues was made possible by Schaudin's discovery of the spirochætæ, we possess in the intensive and prompt treatment (abortive) one more means of preventing it from invading the central nervous system. A second and very important advance in the direction of prophylaxis during the last few years was made by the utilization of Quincke's method of spinal puncture. The routine examination of the spinal fluid of all the luetics in the early secondary stage points out to us those who have their central nervous system invaded. This class of patients, singled out at the

beginning of their neuro-syphilis, get spinal attention and treatment until not only their blood but also their spinal fluid shows no more abnormal reactions. In this way we may arrest the process in its beginning and prevent serious damage to the central nervous system and optic pathways. In other words the treatment for the prevention of lues of the optic paths can have some hope of success only when the infection and the invasion of the nervous system are treated at the earliest possible moment.[1]

Having failed to prevent, the question to be considered next is:

How well do we understand the proper treatment of the optic pathways?

The answer is: As well as we know how to treat syphilis in general and that of the central nervous system in particular.

Does the treatment of neuro-lues differ in any manner from that of syphilis in any other part of the body?

Yes. The last few years have developed a new method of treatment of neuro-lues, consisting of intraspinal and intracranial medication in addition to the general anti-luetic treatment (salvarsan, mercury, and iodides.)

Is there unanimity of opinion among neurologists and syphilographers regarding the indications and efficacy of intraspinal and intracranial medication?

No. There are yet a large number among them who do not believe that intraspinal medication obtains results superior to the general treatment.

Which are the arguments advanced in favor of spinal medication?

First: There are cases of neuro-syphilis, like certain types of tabes and cerebrospinal lues, which do not improve either clinically, nor serologically, by general treatment, but which show rapid improvement during spinal medication.

Second: There are other cases of neuro-lues which improve

[1] Dr. I. Rosen, Chief of Clinic of the Department of Syphilis at the Vanderbilt Clinic, in a personal communication, told me that he has seen several cases of primary lesions (with demonstrable spirochætæ), which never developed secondary skin eruptions, blood or spinal fluid reactions. He thinks that prophylaxis of neuro-lues is possible in patients treated intensively while the infection is still in the primary stage.

during general treatment only up to a certain point, but get entirely well after the spinal medication.

Third: Other cases respond promptly to general treatment, but show frequent recurrences. These become entirely arrested by adding the spinal method of treatment.

Fourth: There are cases of neuro-lues which cannot stand mercury or salvarsan. They show anaphylactic or toxic symptoms, dermatitis, jaundice, etc. Such patients are entitled to spinal treatment and many of them do well with this method.

What reasons are advanced by those (like Sharp, Hammond, Wardner, and myself) who recommend intracranial medication of cerebrospinal lues in addition to general and spinal treatment?

There are cases which do not improve by general or spinal treatment and which are entitled to the application of the therapeutic agent, directly where the pathological process exists, in the cranium.

Why does the general treatment not act in some cases of syphilis of the brain or of the optic pathways?

Because the blood vessels and tissues surrounding them are impervious to medication.

Why, then, is spinal medication not sufficient in such cases?

Because: (1) In many there is a diffuse adhesive process between the meninges and spinal cord and brain. Spinal medication has no chance of diffusing into the spinal fluid and reaching the cranial contents.

(2) Even if there were no mechanical obstacles like exudates and adhesions to the diffusion of the medication upwards, my own experiments as well as those of others (Sharp, Tilney, etc.) have shown that fluids injected into the lower parts of the spinal canal do not extend into the cranial cavity beyond the medulla oblongata and pons, consequently they do not reach the region of the optic nerves.

If spinal medication does not reach the brain substance and optic nerves, how do we explain the good results obtained by this method in a certain number of luetic intracranial lesions?

My explanation is that ***it is not so much the medication as the meningeal reaction, the active hyperæmia, which produces the beneficial effect.*** In some cases this reaction extends all the

way up to the brain and to the most anterior cranial nerves; in others it does not. In the former we get results; the latter need cranial treatment (in order to obtain the reaction in the tissues we wish to medicate).

Speaking from personal experience I can say that there is a group of cases with syphilis of the optic pathways which respond to spinal medication better than to general anti-luetic treatment alone.

To come down to the nucleus of the paper: what course is to be followed in a given case of luetic involvment of the optic pathways?

First: To make a strictly accurate diagnosis recognizing and eliminating or treating all the other factors which may cause the lesion.

Second: To ascertain that there is yet present an active process. End results of a condition which has come to a standstill need no treatment. A partial optic atrophy with no tendency to progress, with negative findings in the blood and spinal fluid, and no clinical evidence of an active neurological disease, should be watched but not treated.

Third: Patients with a vision to counting fingers at a few feet, with very poor fields of vision and atrophic optic disks should not be treated with considerable hope.

There remains the group of cases with $\frac{20}{200}$ vision or more with a fairly good field and in good general condition which belongs to the ophthalmological practice; these cases are to be treated according to the type of neuro-lues and type of optic nerve lesion they are affected with.

Therapeutically, it is of greatest importance to have a clear idea of:

(*a*) *Whether we deal with a tabo-paresis, cerebro-spinal lues, or vascular case;*

(*b*) *What type of optic pathway lesion the patient has;*

(*c*) *In what stage of lues the optic pathway became involved.*

The indications, the dosage, the frequency of treatments, and the method of administration are quite different not only in each type of neuro-lues, but also in each type of optic path lues.

For instance, in a case of papillœdema or papillitis occurring during a course of intravenous salvarsan injections, the

indication is to continue persistently and cautiously with mercury and salvarsan; the condition clears up. If we stop, for fear of increasing the papillœdema, we run the danger of letting the syphilitic process go on unchecked to fatal termination (atrophy).

A case of optic neuritis in the secondary stage has to be treated along similar lines, possibly more energetically. The extent of the condition is greater, the sheaths of the nerves are usually primarily involved, and the question of spinal medication in addition to the general treatment has to be considered.

The optic neuritis, papillitis, and optic chiasm infiltrations of the tertiary stage are an entirely different therapeutic problem. Here we have to deal with the tissues, where a series of biologic changes took place during the years of symbiosis with the spirochætæ or their toxins. I fail to see how we could expect that this sort of modified strain of microörganisms should be attacked by salvarsan and mercury in the same manner as the fresh spirochætæ of the secondary stage. Neither could we expect that tissues, whose resistance to the toxins or spirochætæ has been gradually breaking down, or built up during years of struggle, should be readjusted by the same chemicals and methods as those tissues which are just at the beginning of the infection (primary and secondary stage).

We are in great need of knowing the exact indications for dosage, frequency, and method of administration of our therapeutic agents, and future experience will have to develop this knowledge. We need more than this. We need new methods and better therapeutic agents.

The retrobulbar neuritis type, very rare, would require not only the routine antispecific treatment, but also the serious consideration of a decompression operation, like trephining of the sheath of the optic nerve, if the course of the disease is seriously threatening a permanent extinction of the vision.

Finally the question of optic atrophies.

To my mind a clear understanding of the pathological condition which is causing the atrophy of the optic nerve is absolutely necessary in order to decide what therapeutic road to follow.

Cases of simple optic atrophies with a fulminant course are surely, a small but distinctive group. *There is not one minute's*

time to lose. They are acute atrophies which absolutely refuse to respond to the old routine treatment. This group of acute optic atrophies are to be handled along entirely different lines than any of the other types of atrophies.

The optic atrophy with visible changes of the blood vessels on the disk and retina should have a different treatment; general medication, like small doses of salvarsan intravenously, gradually increasing doses of iodides over a long period of time and cautiously administered soluble salts of mercury injections, together with a special hygiene sparing the cardio-reno-vascular system and building up the general vitality.

Frank neuritic optic atrophies, originating from an optic meningitis need energetic general antisyphilitic treatment and also spinal, or, if necessary, cranial treatment.

As we see, it is therapeutically meaningless to say, "optic atrophy," without mentioning the kind of atrophy we are dealing with.

REPORT OF CASES.

The following cases are selected from a larger number and are reported here because they have been under observation for two to three years, a reasonable time to furnish an idea as to their course and termination. They represent the most frequent types mentioned in the first part of this paper: meningitic, interstitial, vascular, tabo-paretic and illustrate how little in some, how much in others therapeutic attempts may interfere with the march of the syphilitic process towards extinction of vision.

CASE I.—January 23, 1917. Isy A., 35 years old, tailor. *Tabetic optic atrophy.*

Luetic infection fifteen years ago. Patient complains that the right eye is blind for the past five months and that the left eye began to blur a few weeks ago. Vision: right, counting fingers at three feet; left, $\frac{20}{30}+$. Examination reveals both optic disks atrophic, pupils unequal, myotic, Argyll-Robertson. The spinal fluid had 50 cells, globulin +, Wassermann 4+ and a paretic curve (colloid gold reaction.)

Tongue deviates slightly to left, hypalgesia over both maleoli, Achilles reflex diminished left; absent right. Slight accentuation of the second aortic sound.

During the first two weeks of treatment with K. I., strychnin *Hg*, small doses of salvarsan intravenously and intraspinally the vision went down to "hand movement" in the poor eye and $\frac{3}{100}$ in the good eye. The field of vision was so much reduced that he had to be led around.

Under such desperate circumstances intracranial treatment was resorted to on February 15, 1917. The next few days after the treatment the vision diminished to only perception of light. The treatment with small intravenous and intracranial injections of salvarsan was kept up and the vision began to pick up so that four weeks after the first intracranial treatment he was able to call alone at my office from a distance of about twenty-five blocks and even went alone to the hospital changing cars and crossing very busy avenues. His field became larger and his acuity of vision on March 20, 1917, was $\frac{20}{200}$. But the improvement lasted only a few weeks. It began to deteriorate gradually and in April, 1917, we find him with V. O. S. $\frac{4}{100}$ and the following month with V. O. S. counting fingers at three feet. Later on he began to have generalized convulsions, his vision went down to zero in the left eye and hand movement in the right eye, and in December, 1918, he had to be taken to an asylum on account of mental disturbances. The findings in the spinal fluid were as follows:

	Cells.	*Globulin.*	*Wassermann.*	*Lange.*
1917, January 28.	50	+	++++	
1917, February 7.			++++ with 0.2 *c.c.*	paretic curve

Intracranial treatment begun on February 15, 1917.

1917, February 15.	50	+++	++++ 0.2*c.c.*	paretic
1917, March 12.	0	0	++++ 0.2	

The blood serum Wassermann remained 4 + throughout.

The fields of vision very much contracted above (to about 10° to 15°) from fixation point, gradually diminished until cranial treatment was administered, then improved for several weeks.

Remarks.—This patient is a tabo-paretic with an acute atrophic process in both optic nerves. The rapidity of diminution of vision in spite of and during the general treatment, the marked temporary improvement of the vision and of the general condition after the first cranial treatments and the final complete failure are the outstanding features.

CASE II —Alb. B., 39 years old, insurance agent.

Tabes with bilateral simple optic atrophy. Luetic infection denied.

The right eye became blind during August–November, 1914, and the left eye began to fail sometime (?) later. In February, 1915, when he first came to the Eye Department, of the Vanderbilt Clinic, his vision in the left eye was $\frac{3}{100}$; glasses could not improve it; right eye, Vision—0. Examination on February, 1916, reveals bilateral simple, optic atrophy; rigidity of the pupils to light and to accommodation (?), absence of patellar reflexes, Achilles diminished. Field of vision, contracted concentrically to about 40 degrees all around with a marked indentation below and nasally.

Blood ++++ Wassermann, spinal fluid ++++.

16 cells, ± + globulin, luetic curve.

V. O. D. = 0; O. S. $\frac{1}{100}$.

After a course of thirty-one spinal injections of salvarsanized serum, eleven intravenous injections of salvarsan, twenty-one muscular of *Hg*, given during a period of about two years his vision was found $\frac{5}{100}$ and the patient complained that he feels his sight is diminishing steadily. The intracranial treatment was begun on February, 1917. He received three injections of salvarsanized serum, ½ to 1*m* gr. of salvarsan to the dose and his gradual loss of vision was arrested for about three months. Then it began to deteriorate again and in February, 1919, examination showed: Vision right and left—0. Mentally normal.

Blood and spinal fluid findings.

	Blood.	*Cells.*	*Globulin.*	*Wassermann.*	*Lange.*
1915.	4 +				
1916, Oct.	1 +	16	±	4 + 1*c.c.*	luetic curve
1916, Dec.		3	±	4 + 0.6*c.c.*	luetic
1917, Feb.				4 + 0.6*c.c.*	luetic
1917, Mar.				4 + 0.6*c.c.*	

The field of vision in the left eye contracted steadily first below and nasally, then, the temporal part of the field began to lose ground and this scotoma crossed first the point of fixation.

Remarks.—This patient is a tabetic who developed an acute process of optic atrophy losing rapidly the vision in the right eye. It seems that the process was twice temporarily arrested; first during the general and spinal treatment for about twenty-

one months; second during the three months of cranial treatment.

CASE III.—Pet. K. Age 40. Cabinet maker. *Cerebro-spinal lues; bilateral optic atrophy (neuritic.)*

Vision began to fail in the left eye sometime in August, 1915, and in the right eye a few months later. In December, 1915, he had to give up work on account of his poor sight. In his personal history we find; headaches, severe and continuous for three weeks, ten years ago; rheumatism in back and hands; wife had four miscarriages and one living child.

The examination (November, 1916) gives the following findings: Slight weakness of right side of the face, diminished reflex of left biceps, and both tricepses, poor coördination of arms (pointing finger to finger), absence of patellar reflexes, suspicious right Babinski, Oppenheim, and Gordon. Spinal fluid ++++ Wassermann (0.6); Lange, paretic; cells 4; globulin +++ V. O. D. hand movement above, temporally and nasally. O. S. L. P. pupils; unequal, moderately dilated, rigid to light and accommodation.

Fundus.—Bilateral optic atrophy (neuritic).

Treatment.—Having had K. I. and strychnin, *Hg* and salvarsan for more than one year before he came under my observation, without any change in vision, the intracranial treatment was decided upon. First treatment, November 21, 1916. The following cranial treatments were given on December 1st, December 19, 1916–February 1st, Mar. 14th, April 20, 1917. The vision began to improve slightly after the second injection when he could count fingers at five feet distance with his right eye and see "hand movement" with the left eye. His field improved so far as to give him the possibility of walking about in the room and in the street for some distance without bumping into objects. April 28, 1917: Vision, right counting fingers at four feet; left "hand movement." The vision remains slightly improved until September, 1917, when we find vision, right counting fingers at four feet; left counting fingers at one to two feet. Soon after the vision began again to fail and in November, 1918, he had vision, right "hand movement" at one foot; left "hand movement" at six inches. The field of vision, restricted to the upper, lower, and nasal parts, improved somewhat when the acuity of vision was better.

Spinal fluid and blood findings.

	Blood.	*Sp. Fl.*	*Cells.*	*Glob.*	*Wass.*	*Lange.*
May, 1916.	2 +		9		4 + 0.6*c.c.*	paretic
Nov. 1916.			4	3 +	4 + 0.6*c.c.*	paretic curve
Feb. 1917.			0	0		
April, 1917.			6	—		

Remarks.—This patient with cerebro-spinal lues and descending neuritic optic atrophy showed unmistakable signs of temporary, slight improvement after cranial subdural injections of salvarsanized serum.

CASE IV.—L. Z. Age 33 years. *Cerebro-spinal lues, bilateral optic atrophy (neuritic) with marked retino-vascular changes.*

Left eye blind since October, 1915; the right eye began to fail gradually and steadily soon (?) after. History of chancre fifteen years ago. Loss of sexual power six months ago. Everything else in family and personal history, negative. Examination October 27, 1916, reveals: Vision, right, $\frac{10}{100}$, with correction $\frac{20}{100}$; left, "hand movement."

Pupils.—Small, irregular, unequal, rigid to light and accommodation.

Fundus.—Bilateral, simple optic atrophy with marked sclerosis of the retinal arteries.

Blood Wassermann ++++; spinal fluid Wassermann ++++ (0.2 *c.c.*); cells 14; globulin ++; Lange; paretic curve.

Course of vision and treatment.—After having received K. I. and *Hg* by mouth, eight spinal injections of salvarsanized serum, ten intravenous injections of salvarsan, and nine intramuscular injections of *Hg* his vision in the right eye was found slightly diminished to $\frac{15}{100}$ (with correction) and in the left eye, 0. The intracranial treatment was given, once, on February, 1917, and vision on March, 1917, was found $\frac{20}{30}$ in the right eye; nil in the left eye. The vision remained the same until June, when patient was taken to an asylum on account of sudden generalized convulsions and mental disturbance.

The field of vision contracted above and temporally, remained the same during the entire time the patient was under observation.

Blood and spinal fluid findings.

	Blood.	*Sp. Fl.*	*Cells.*	*Glob.*	*Wassermann.*	*Lange*
Oct., 1916.	4 +					
Nov. 4, 1916.			14	2 +	4 + 0.2*c.c.*	
Nov. 15, 1916.			30	3 +	4 + 0.6*c.c.*	paretic

Remarks.—This patient with cerebro-spinal lues and neuritic optic atrophy with marked retino-vascular changes showed a temporary improvement or at least an arrest of the process of degeneration of the optic fibers after the cranial treatment.

CASE V.—Rose Sol. 29 years old, cook. *Cerebro-spinal lues and simple optic atrophy with sclerosis of retinal blood vessels.*

Luetic infection, probably after marriage, twelve years ago. Vision began to fail in right eye in July, 1915. Came under observation in July, 1916, when vision was: R. $\frac{15}{400}$; L. $\frac{20}{20}-$ with correction.

Neurological examination revealed: right knee jerk diminished; Achilles reflex weak on both sides.

Pupils unequal; Argyll-Robertson reaction.

Treated with strychnin and K. I. drops for six months, during which time the vision diminished to R. $\frac{5}{200}$; L. $\frac{20}{70}$. Received from January, 1917, four spinal injections of salvarsanized serum, four intravenous injections of 30*ct* grs. of salvarsan, each and four mercury intramuscular injections. The vision continued to fail during this treatment and at the end of the course we find her with V. R., L. P.; L., = $\frac{20}{200}$. Intracranial treatment on July 3, 1917; vision continues to diminish and about five months later all she saw was light perception.

The fields of vision were contracted concentrically to about 40 degrees all around in September, 1916. Then, during the next two months the right field retracted below to the horizontal meridian and temporally to the median vertical meridian, and finally vanished completely. The left field began to show two indentations, one above and temporally and one below and nasally, which became gradually deeper, but never met to separate the field in two islands.

The spinal fluid changes were as follows:

	Cells.	*Globulin.*	*Wassermann.*	*Lange.*
Dec., 1916.	50	+	4 + 0.4*c.c.*	paretic
Jan., 1917.	18	+	4 + 0.2*c.c.*	
Mar., 1917.	50	+	4 + 0.4*c.c.*	paretic curve.

The blood serum Wassermann remained 4 + throughout.

Remarks.—This patient became progressively worse, both during the old routine treatment with K. I. and strychnin and the newer method with spinal and cranial injections. The latter was used only once, because the patient set up a catarrhal jaundice which lasted a few months.

CASE VI.—Bess B. Age 33 years. Housework. *Tabes. Bilateral optic atrophy (meningitic).*

Came under my observation at the H. Knapp Memorial Eye Hospital on December 18, 1916, complaining that her

vision began to fail in the right eye six months before and that the left eye is also failing lately very rapidly. A course of seven intravenous injections of salvarsan was given at another institution previous to calling at our clinic. Luetic infection soon after marriage several years ago.

Examination reveals: Absence of patellar and ankle reflexes, diminished wrist jerk, slight hypalgesia of both lower extremities.

Vision.—Right $\frac{20}{100}$; left $\frac{1}{10}$ not improved by glasses.

Pupils.—Irregular, unequal, slightly dilated, very sluggish to light and accommodation.

Fundus.—Both optic nerves grayish-white, atrophic (*optic atrophy from descending neuritis*).

After a course of six spinal injections, six Hg in the muscles, and six intravenous injections of salvarsan, we find her on May 10, 1917—Vision: right $\frac{20}{100}$, left $\frac{1}{10}$ ++.

The acuity of vision remained stationary up to December, 1918, when seen last. She could read Jaeger 1 with the left eye (adding + 1 sph. to her distance glasses) while she could not read ordinary print before the treatment started. The blood serum Wassermann was reduced from 4 + to 2 + and the spinal fluid findings were as follows:

	Cells.	*Globulin.*	*Wassermann.*	*Lange.*
Dec., 1916.	250	2 +	4 + 0.10*c.c.*	paretic curve
Jan., 1917.	40	2 +	4 + 0.2*c.c.*	paretic
Jan., 1918.	25	3 +	4 + 0.2*c.c.*	paretic

The fields of vision followed the usual course. The right field concentrically contracted showed also a marked indentation below and nasally which, however, disappeared almost entirely after a few spinal injections. The left field of vision slightly contracted (about 10–15 degrees) remained stationary during the entire period of about 2½ years, while she was under my observation.

Remarks.—This patient with tabes and meningitic descending optic atrophy has responded to the spinal treatment from the beginning. The exudative process having been resorbed, the failing vision was arrested and presumably some nerve fibers resumed their function, as evidenced by improvement of acuity of vision.

CASE VII.—Harry L. Age 40 years, electrician. *Tabes; gummatous infiltration in the region of the optic chiasm; descending bilateral optic atrophy.*

Came under my observation at the H. Knapp Memorial Eye Hospital in September, 1916, complaining of rapid failure of vision. Denies lues. Had been exposed to a strong electric flash seven years previously and says that his sight remained weaker ever since. But the left eye is blind since two years and the right eye is failing rapidly for the past five months.

The neurological examination revealed: slight incoördination of the right arm, markedly diminished reflexes of the wrist, biceps, triceps; absence of reflex knee jerks, and Achilles. X-ray skull negative.

Ophthalmological examination.

Vision.—Right $\frac{18}{20}$; left, "hand movement"; glasses do not improve.

Pupils.—Moderately dilated, unequal, irregular. Right sluggish to light and convergence; left rigid to both.

Fundus.—Right: apparently simple optic atrophy; sclerotic changes of some of the retinal arteries. Left: optic disk slightly raised and blurry above. Sclerotic changes of the retinal arteries near the disk.

Field of Vision.—Classical bitemporal hemianopsia.

Patient was admitted to the hospital and given a course of six small doses of salvarsan intravenously between September 20 and October 23, 1916. Also K. I. increasing doses up to 60 grains t. i. d. During this time his vision continued to fail and we find him in November, 1916, with $\frac{20}{100}$ right, hand movement left. From November, 1916, on, he began to get in addition to salvarsan and mercury spinal injections of salvarsanized serum. He received twelve intravenous of salvarsan, ten mercury, and seven spinal injections. The vision ceased to fail right after the first spinal treatment. Repeated examinations during 1917 and 1918 showed no signs of deterioration; and vision remained R. $\frac{20}{100}$; L. fingers at 2–3 feet (nasally).

Spinal fluid findings.

	Cells.	*Globulin.*	*Wassermann.*	*Lange.*
Nov., 1916.	0	± doubtful	4 + *c.c.*	luetic curve
Dec., 1916.	4	±	4 + *c.c.*	luetic
Jan., 1917.	3	±	4 + *c.c.*	luetic (weakly)

The blood serum 4 + Wassermann on September, 1916. The right field of vision showed complete temporal hemianopsia, but normal in extent in the seeing portion for all colors. The left field consisted of only a small remnant in the nasal lower portion seeing only hand movement, when patient first came under observation. Later on the field

became larger but did not extend to the temporal side. The acuity of vision also increased to counting fingers at a distance of a few feet.

Remarks.—In this case, more than in any other, I have the feeling that the arrest of failing vision had something to do with the spinal treatment. To me it was a striking illustration how important it is not to go half heartedly about such cases. After having witnessed a reduction of vision from $\frac{20}{60}$ to $\frac{20}{400}$ + during a few weeks, while patient was undergoing the salvarsan course, it required quite an effort to decide to continue the salvarsan and add mercury and spinal injections to the treatment. I feel almost certain that this addition arrested the process. This consisted of an exudate in or gummatous infiltration of the chiasm, causing partly a blocking of its function and partly a degeneration of the fibers. The methods of reaching the chiasm by way of the blood stream alone were insufficient, but the spinal treatment must have caused a meningeal reaction extending up as far as the chiasm.

CASE VIII.—Anthony B. Age 60 years, colored. Hotel doorman. *Cerebrospinal lues; bilateral simple optic atrophy (descending neuritis).*

Referred by a physician to the H. Knapp Memorial Eye Hospital on January, 1917. Left eye blind for past three years; right eye failing for a few months.

Chancre without skin eruption thirty years ago. Neurological and general examinations—negative.

Ophthalmological examination.

Vision.—Right eye—$\frac{20}{40}$ with correction: left—0. Pupils slightly irregular, equal: right reacts to light and accommodation: left rigid to light, reacts to accommodation.

Fundus.—Optic atrophy (descending neuritis?).

After having five mercury injections and K. I. drops for a few months without succeeding in arresting the failing vision in the right eye he was referred to our clinic. Here he received a course of three spinal treatments, six intravenous injections of salvarsan, and six mercury between January and May, 1917.

His vision remained stationary (R.—$\frac{20}{40}$ L.—0) during 1917, and 1918. In February, 1919, when examined again he had R.—$\frac{20}{20}$ with his glasses, could read Jaeger 1 with an addition of a corresponding plus sphere. He had not received any treatment for more than one year and apparently some process of exudation must have taken place

lately, which resulted in slight reduction in the acuity of vision.

The blood Wassermann was 4 + when first seen and the spinal fluid changes were as follows:

	Cells.	*Globulin.*	*Wassermann.*	*Lange.*
Jan., 1917.	50	3 +	4 +	
Feb., 1917.			4 + 0.2	paretic
Mar., 1917.			4 + 0.6	

The fields of vision slightly contracted for white, more contracted for red, showing an indentation of about 20 degrees above and temporally, remained the same in extent during the last two years.

Remarks.—This patient with both optic disks gray-white, completely blind in one eye, with beginning failure of vision in the other, responded to the combined treatment (spinal and general) and kept his vision intact for two years. Whether optic atrophies behave like this even when not treated or when treated by the old methods, is hard to say. My experience is too limited to affirm or deny this, and reports from literature are lacking in details of this kind. The process must have been a meningeal exudate since the spinal fluid contained a large number of cells and the treatment succeeded in causing resorption of the exudate. Its location must have been in the posterior portion of the optic nerve, sparing them acular bundle (which here is centrally located, very near the chiasm, as suggested by the beginning temporal hemianopsia, marked indentation of the field above and temporally).

Case IX.—Harry Cash. Age 24; railroad engine fireman. Diagnosis. *Lues (secondary stage) with bilateral papillœdema.*

Called at the H. Knapp Eye Memorial Hospital in September, 1914, complaining of blurriness of vision of the right eye. History of luetic infection in January, 1914. On examination (by late Dr. O. Schirmer) vision was found normal in each eye ($\frac{20}{15}$ −).

In December, 1916, he came back complaining of pains in the head and failing vision for one week. He had received eighty-five mercury and eighteen salvarsan injections since June, 1914. Vision was R.—$\frac{20}{30}$+; L.—$\frac{20}{50}$.

Fundus (examined by late Dr. Schirmer, Dr. Knapp, and myself). Marked papillœdema on both sides, considered by

the first two distinguished examiners as a characteristic neuro-recidive. A course of spinal treatments in addition to a more cautious general treatment was outlined and carried through.

The vision varied during the following months in the right eye between $\frac{20}{50}$ ++ and $\frac{20}{80}$; in the left eye between $\frac{20}{80}$ ++ and $\frac{20}{80}$. The optic disks remained sometimes more, sometimes less bulging and œdematous.

By March, 1917, we find him with a vision greatly impaired (R.—$\frac{20}{80}$; L.—$\frac{20}{80}$.) He had received during the four preceding months nine spinal, eight mercury, fifteen salvarsan injections. Admitted to the hospital for rest, sweats, diet, and K. I. Condition same after four weeks. During the following six months vision gradually returned to $\frac{20}{30}$ ++ in the right eye and $\frac{20}{40}$ in the left. During these six months he received nine mercury and nine salvarsan injections and K. I. by mouth.

In April, 1918, we find him with a vision of $\frac{20}{30}$ + right; $\frac{20}{20}$ ++ left. The fundus examination shows, right, the optic disk congested, the retina adjoining it above nasally and below œdematous for a distance of about ½ disk diameter; left, distinct œdema of the retina adjoining the nasal portion of the disk, stretching over an area of about ¼ disk diameter; also a large floating opacity in the vitreous.

In September, 1918, the vision in the right eye was again $\frac{20}{100}$; in the left eye $\frac{20}{40}$. The right eye, according to the patient's statement, failed suddenly one week before calling.

Mercury inunctions for one month, and right eye recovered vision to $\frac{20}{30}$ −; left $\frac{20}{40}$. March, 1919, vision again $\frac{20}{30}$ right; $\frac{20}{40}$ left.

Blood and spinal fluid findings.

	Cells.	*Globulin.*	*Wassermann.*	*Lange.*	*Serum*
Dec. 7, 1916.	210	2 +	4 + 0.1*c.c.*	luetic	4 +
Dec. 21, 1916.	30	1 +	4 + 0.2	"	
Jan. 8, 1917.	10	2 +			
Jan. 17, 1917.	41	2 +	4 + 0.2	"	
Feb. 7, 1917.	8	2 +			
Feb. 14, 1917.	1	±	4 + 0.4		2 +
Feb. 23, 1917.			4 + 0.4		
Mar. 14, 1917.	15	±	4 + 0.2		
Aug., 1917.					4 +
Nov., 1917.					1 +
Sept., 1918.			4 + 0.4		1 +
Jan., 1919.					2 +

Repeated very careful neurological examinations—negative.

The fields of vision taken almost every month during the three years of observation showed marked variations as to their periphery, central and paracentral portions. At times the fields were moderately, concentrically contracted, at other times they showed several paracentral scotomata. The blind spots were constantly enlarged, the right much more than the left one.

Remarks.—The remarkable points about this case are:

(1) The numerous recurrences;

(2) The record of treatment (K. I., spinal, intravenous, and muscular injections) carefully administered with long periods of rest between;

(3) The absence of permanent damage to the optic fibers—in spite of the length of the process and repeated recurrences.

What is the condition we are dealing with in this patient?

Is it a papule-like process in the optic disks? Is it a gummatous process? Is it a nest of spirochætæ?

Papules, judging from the way they behave in the iris or other parts of the body, respond very readily to salvarsan and do not recur if treatment is kept up.

The repeated recurrences of the œdema of the head of the optic disks, the little damage done to the fibers, the persistency with which the Wassermann plus reaction recurred in the spinal fluid are very suggestive for the presence of a focus of spirochætæ in the optic disks. But of course this is only a presumption.

SUMMARY.

1. "Earliest" diagnosis versus late diagnosis of syphilitic involvement of the optic pathways is only possible by the routine, periodic ophthalmologic examination of every luetic from the very beginning of the infection throughout his entire life.

The earlier this is brought home to the general practitioner and syphilographer the sooner ophthalmologists have made a very valuable contribution to the practice of medicine.

2. The manner in which the subject of syphilitic optic neuritis and optic atrophies is treated in the classical text-books is more of a handicap against its proper understanding. This

chapter will have to be rewritten by the pen of a ophthalmologist interested in the neurological and syphilographic aspect of the subject.

The importance of this point of view is made patent by the consideration of the possibilities of making a more precise diagnosis and prognosis and mapping out clearer indications for treatment. Furthermore, it brings us nearer to the nucleus of the therapeutic problems concerning syphilis of the central nervous system and of the cranial nerves as a whole.

3. The few cases reported in this paper are selected to illustrate various types of luetic involvement of the optic pathways and their response or lack of response to the old and new methods of treatment. They suggest a number of interesting questions, like:

Why did they fall into the hands of the ophthalmologist years after the condition had started?

Why did many of them fail even after the ophthalmologist had them under treatment?

What is wrong with our present system of handling this class of patients?

Can part of it be remedied at the present time?

What is wrong with our methods of treatment, and what with our therapeutic agents?

Does the entire subject of syphilis of the central nervous system stand a chance of being rapidly advanced if the old, inefficient methods of study are continued?

Is it not time that special institutions should be established for the treatment and study of syphilis by complete teams of physicians and pathologists?

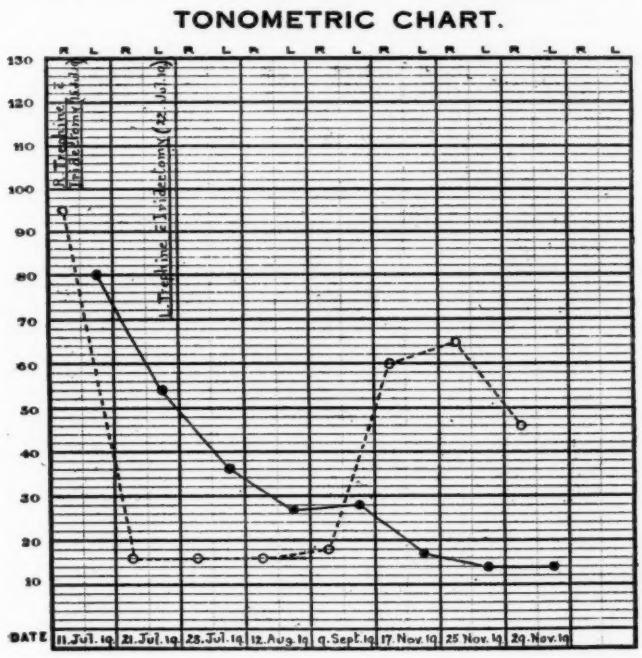
Is it within the sphere of ophthalmologists to take active part and take the lead in such a movement?

A TONOMETRIC CHART.

By Mr. T. HARRISON BUTLER, Birmingham, England.

(With two figures in the text.)

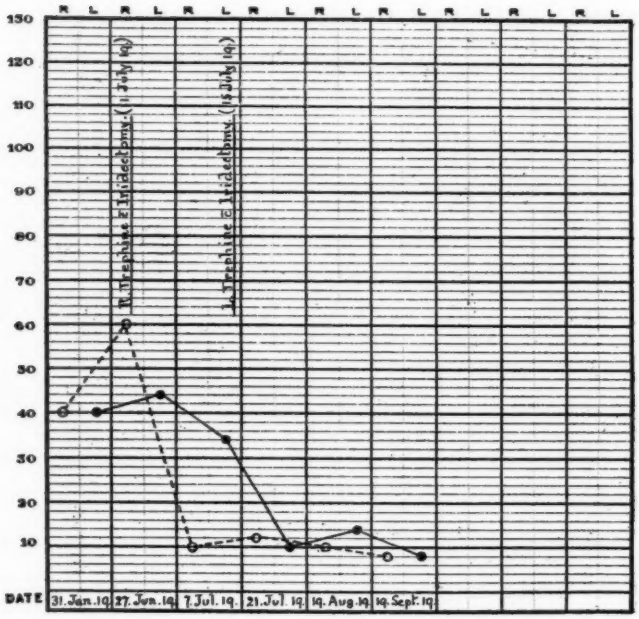
I HAVE had the enclosed chart made to simplify the treatment of a case of glaucoma. These cases attend a hospital for a long time, and often appear after some considerable lapse



NAME Lydia P. aet. 59.

of time. To get a grip of the progress of the disease and of the effect of treatment it is necessary to read all the notes and to sort out the Schiotz readings, which may be entered haphazard all over the case-sheet. The chart shows at a glance the whole history of the patient, and is a great saving of time. I enter the tension of the right eye in red ink, that of the left in black. For the purpose of reproduction I have drawn the curve for the right eye in a pecked line. I am indebted to my house surgeon Mr. Sichel for drawing the curves. The charts may be obtained from Weiss of London.

TONOMETRIC CHART.



NAME Samuel S. aet. 71.

LETTER ON THE ROD SCREEN TEST.

By Mr. ERNEST E. MADDOX, Bournemouth, England.

Dear Dr. Knapp:

May I congratulate Captain Percival Dolman, M.C., on his admirable researches described in the September, 1919, number of these Archives, which I have taken for twenty years, into the "pros and cons" (and especially the "cons") of the rod test. It is always a pleasure to see a record of careful work, and I have no wish to show partiality to any test of my own. Indeed, it is probably impossible to have a test that is perfect all round. Perhaps I may be allowed to offer a few thoughts that bear on the matter.

Firstly, all tests for ocular balance divide themselves into two classes: (1) Monocular occlusion tests. (Screen tests, parallax, etc.) (2) Simultaneous vision tests. (Phorometers, erect prisms, glass rods, etc.) I have an impression that all the first group tend to display greater divergence (or less convergence) than the second group, for the reason that in the first case one eye only stands "to attention"; whereas in the second both so stand, though the fixing eye of course more than the other. The converging center, I think, is not so quiescent when both eyes are exposed, though dissociated, as when one is absolutely cut off. I have sometimes seen cases of exotropia in which the diverging eye, when covered by a screen, diverged several degrees further. The tonus of the converging center when both eyes are open, but dissociated, may be likened to the hum of a motor car at standstill. When one eye is occluded the hum becomes a little slower. The glass rod, therefore, in common with prism tests may be expected to show in many cases a trifle less convergence or more divergence than screen tests.

Secondly, I quite agree with Dr. Dolman that some patients, instead of projecting the streak of light to the distance of the spot of light, project it nearer to themselves. This may, as he suggests, tend to cause a slight convergence, stimulated by the apparent proximity of the line. I would go further, and say that, sometimes, even the point of light may appear nearer to the patient than it really is, especially in a totally dark room. In ordinary life we are accustomed to think light is distant in proportion to the mist which intervenes; hence it is natural to suppose a very bright light nearer to us than it really is, unless the objects about it are sufficiently visible to correct this impression. Dr. Dolman has wisely made his light not too bright, and I have always advised the room to be only partially darkened. To get the best effect of all, a point of light in the center of a square yard of velvet in a room sufficiently darkened to avoid bright reflections from objects in it, gives the best result. To ensure accommodation a series of small figures cut out of white paper may be gummed to the velvet at intervals of a centrad from each other. In measuring hyperphoria the rods may be considered quite truly since the converging center is a negligible factor.

Thirdly, the variability of the line of light is of two kinds. The tonus of the converging center is a fluctuating quantity, so that the eyes wander more or less when fusion is suspended, and the movements of the light streak merely portray this to the mind, and are indeed an expression of the fidelity of the test. Another class of irregular movements of the line, however, of an undesirable kind is due, as Dr. Dolman points out, to alternate fixation of the line, and of the point of light. To overcome this he rightly recommends screening the disk of rods, with brief unscreening at intervals. The following quotations from my former writings may be of interest. "In addition, therefore, to placing the rod before one eye, it is sometimes well to exclude that eye, and expose it momentarily, that the line of light may be seen in a position answering to the deviation on exclusion" (*Ocular Muscles*, 1898, p. 357). Again, "Should there be any suspicion that in spite of the dissimilarity of the images, the mind makes some slight attempt to unite them, the glass rods, while in position, should be screened with a visiting card, and the patient be instructed to

state the position of the red streak at the first instant of its appearance following the sudden withdrawing of the card. In this way we really discover the position of an eye excluded from vision." (*Ophthalmoscope*, vol. x., p. 130.) I feel indebted to Dr. Dolman's investigation for indicating the desirability of doing this more frequently, or as a regular thing when very small departures from the normal require investigation. For considerable deviations it is unnecessary, though for the sake of uniformity, it might be well to use it always with aviators.

Fourthly, the rod test has been credited with a tendency to fusion by some authors. It has always seemed to me remarkably free from this, since the line will sometimes stand almost touching the point of light, with no tendency whatever to coincide with it; the same being true when an extremely weak prism is used to transfer the streak to the other side of the point of light. It is taken for granted that complementary colors are used for the two eyes, the rods being red and the glass before the other eye being deep green. For color-blind patients the one might be blue and the other yellow.

Fifthly, in my earliest experiments with the rods I was greatly impressed with their ability to demonstrate low degrees of anisometropia, as shown by the different reading obtained when the disks of rods are placed before each eye in turn. When the rods first came into being I recorded somewhere that sometimes so little as a quarter diopter of difference between the two eyes can be thus detected, so that we might make some use of this test after the correction of refraction, when there is reason to suspect that the eyes are *not* equally fully corrected; for this purpose the rod screen test would be most suitable.

Sixthly, the chief advantage of the rod test over the prism test (double prism excepted) is that the reading is not apparently affected by slight inaccuracies in the position of the rods or of the head. Phorometers, however, are set so well that they do not come into this comparison. As shown elsewhere, any complication introduced by co-existing cyclophoria is best met by the glass rod.

In Conclusion, the inaccuracies attributed by Dr. Dolman to the rods are all of a slight order which scarcely come into the

range of ordinary practical work. They are practically "nil" in the measurement of hyperphoria. In practice we do not take much account of tiny horizontal deviations. For the competitive and comparative measurements of aviators, however, more strictness is essential, and here is the great value of Dr. Dolman's investigation. His recommendation of the more constant employment of the rod screen test for work of this kind is a distinct step in the right direction.

REPORT OF THE TRANSACTIONS OF THE OPHTHALMOLOGICAL SECTION OF THE ROYAL SOCIETY OF MEDICINE.

By Mr. H. DICKINSON, London.

The ordinary meeting of this Section was held on December 3d, the President, Mr. W. T. Holmes Spicer, occupying the chair.

Mr. G. Potts exhibited a boy who had severe **keratitis following upon an explosion of black powder.** The cheeks and eyes were scorched, the latter so badly that the sclera, cornea, and conjunctiva could not be separately distinguished. Under cocaine, the sclera and cornea were cleaned, and there remained a nebula of the left cornea, almost amounting to a leucoma. The case was now clearing up.

Mr. Potts next showed a case of **detached retina with an unusual condition of the conjunctiva.** In the spring of 1900 the patient contracted rheumatism while serving with the forces in the South African War, and since that date he had been subject to attacks of rheumatism at frequent intervals. His eye trouble appeared to date from 1914, his complaint then being of symptoms of iritis in the left eye. The right conjunctiva and sclera were thickened and œdematous, the sclera having a fatty appearance. The subconjunctival veins were somewhat dilated, and the pupil in each eye was tied down by posterior synechiæ. The man had myopic astigmatism. Vision, with glasses, right $\frac{6}{18}$, left $\frac{6}{9}$. He was put upon 10 grs. of iodide of potassium, but this caused colic, and neuritis in the legs. Four weeks ago he had iritis in the right eye, and the fundus could only with difficulty be made out; there was a hazy appearance of the lens. The pupil was contracted.

There was no history of injury or of syphilis, but a Wassermann reaction had not been done.

Dr. A. HUGH THOMPSON said he considered there was a distinct increase in intraocular tension, and this, taken in conjunction with the proptosis and the retinal detachment, pointed to the presence of a new growth, which he thought would prove to be tubercular.

The PRESIDENT said the case reminded him of some syphilitic cases he had seen.

Mr. MALCOLM HEPBURN showed a patient with an **aneurysmal varix of the cavernous sinus,** in order to ascertain whether anything further could be done. The common carotid had been tied, but noises in the head were still present and were a source of great trouble. Vision was not yet affected. The man's supraorbital vein was dilated, and he, the speaker, wondered whether it would be of any use to tie that.

Mr. CHARLES HIGGENS mentioned a case of his own in which the tying of a prominent vessel, not the jugular, cured the noises in the head, and the hemiplegia also present disappeared.

Mr. PERCY FLEMMING, as a result of the carotid being tied in five cases which had come under his notice, recommended that nothing further be done in this case unless the symptoms became more pronounced.

Mr. J. H. FISHER said that in some cases the carotid was injured when the base of the skull was fractured: in others the artery might burst spontaneously on account of the vessels being atheromatous. The treatment to be followed would differ according to which category the case belonged to. When ligation was done, it was very important to keep the patient at rest in bed for a long period afterwards; the present tendency was to discharge these cases from hospital too soon.

Mr. R. R. CRUISE related the procedures in the tying of successive vessels—unsuccessfully—in a very distressing case, in which the man felt life was insupportable.

Discussion on Dr. Batten's paper on "The Need for Ophthalmic Physicians for the Advancement of Ophthalmology."

Dr. C. O. HAWTHORNE, in opening the discussion on this contribution, reminded his hearers of his view that a consider-

able part of the work in the field of ophthalmology required not the art and craft of the surgeon, but the diagnostic and therapeutic methods of the physician. But he objected to the narrow title of "ophthalmic physician," just as he would object to be known as a non-ophthalmic physician. The physician's work was specially concerned with such conditions as ocular paralyses, pupil disturbances, cycloplegias, optic neuritis, optic atrophy, retinitis, and retinal and other intraocular hemorrhages. It was a mere accident that patients suffering from any of these states went first to either the ophthalmologist or the ophthalmic hospital. If the latter was to deal adequately with the kinds of cases he had mentioned, they must be well equipped for the purpose, and have the needed personnel. He did not see how the position Dr. Batten had taken up could be challenged; it concerned the good repute of the profession, the progress of scientific medicine, and the patient's welfare.

Mr. C. HIGGENS said the present practice was to refer patients sent to the oculist for an opinion to the proper specialist. Mr. W. LANG agreed.

Mr. ERNEST CLARKE averred that the remedy for the state of affairs alleged by Dr. Batten was to urge medical students who proposed to be ophthalmologists to learn more general medicine; there must be a broader range of education.

Mr. E. TREACHER COLLINS reminded the meeting of the history of Moorfields Hospital, in which there had been a gradual displacement of the physician by the surgeon since 1804. With the steady advancement of knowledge came the inevitable tendency to split it up into several departments; but there must be borderline cases, and these were liable to be overlooked by rigid workers in one or other specialty. Hence it would be an advantage for men to take up two departments, their position constituting a sort of liaison between the two. The dominant need was for the complete ophthalmologist: the man who was eager to know everything possible about any disease in which the eye could be affected.

Mr. ARTHUR W. ORMOND contended that, for appointments on the staffs of ophthalmic hospitals, the London M.D. should be equally eligible with the London M.S. He would, however, object to the division of the staffs into those who operated, and

those who did not; the need was for a broadening of the specialty. Men must be allowed more time for the study of the medical side; at present the younger members of staffs were inundated with refraction work.

Mr. LEIGHTON DAVIES objected to the suggestion that the ophthalmic surgeon was incapable of investigating the conditions which resulted in eye troubles. It was a pity that men had to qualify in this special work after their general medical curriculum had ended, but it had the advantage of giving a wider general medical knowledge.

Professor J. H. PARSONS thought the chief value of Dr. Batten's paper was the stress it laid on the feeling which many ophthalmologists must have that they are not as fully able to deal with the medical as with the surgical aspect of their cases. He, the speaker, thought workers in the specialty ought also to render themselves competent to deal with physiological optics, and the relationship of ophthalmology to industrial conditions. He agreed with Mr. Collins's point, that workers in this field were ophthalmologists—neither physicians nor surgeons as such. For those who intended to enter the ophthalmic ranks, there must be provision for studying every branch, and the opportunities for such study must be greatly multiplied.

Dr. BATTEN, in a brief reply, said it was lamentable that many eyes should have been so badly operated upon, as they must be when men operated so seldom. Perhaps the main stimulus he had for writing the paper was the feeling that men who were not competent to operate properly should not have operations to do, and with the limited amount of operation material, it was not possible for every ophthalmologist to gain sufficient operation experience to ensure good work.

REPORT OF THE PROCEEDINGS OF THE SECTION ON OPHTHALMOLOGY OF THE NEW YORK ACADEMY OF MEDICINE.

By Dr. ELLICE M. ALGER, Secretary.

NOVEMBER 17, 1919. DR. ARNOLD KNAPP, CHAIRMAN.

REPORT OF CASES.

Dr. J. H. Claiborne, **retinal hemorrhage from intestinal intoxication with complete recovery after high lysis.**

The patient, male, 56 years old, after several weeks of over-indulgence in food and drink noted a sudden disturbance of vision in his left eye. Was seen on January 27, 1919, and the following condition was present. Right eye, myopia 12 D.; S. $\frac{20}{100}$. Interior normal. Left eye: S. $\frac{20}{40}$. There were several large hemorrhages about the disk. General arterial tension slightly elevated. Urine strongly acid, indican in excess, few hyaline casts, and many calcium oxalate crystals. Wassermann negative. Feces: highly acid, indol 5 +, bacteria gram. +. He was treated under Dr. Dwyer's direction with enemas and diet. On April 8th the sight was $\frac{20}{30}$; the hemorrhages are absorbed but the disk is pale.

It seems reasonable the same result might have been attained if the old methods of treatment had been employed, such as rest in bed, purgatives and iodide of potash, but at any rate, there can be no doubt that the importance of recognizing the intestinal tract as the seat of the cause of many affections of the ocular structures has not been exaggerated and that a fertile and wide field of investigation has been thereby opened. I take this chance to express my admiration and appreciation of the excellent work that Dr. Dwyer has done in this field.

Dr. C. W. STEVENS, **Trigeminal neuralgia** (appears in full in this issue).

DISCUSSION: Dr. ALLEN reported the case of a man who had epileptiform seizures, often two or three times a month, which had been completely relieved by an operation by Dr. Stevens. Dr. Allen thought that the examination of the eye muscles was very important.

Dr. TYSON asked what operation was performed by Dr. Stevens and whether there was any treatment other than the operation.

Dr. KNAPP asked in how many cases of fifth nerve neuralgia Dr. Stevens had found muscular trouble of the eyes.

Dr. STEVENS replied that the operations performed were of the kind designated as "extendo-contractions" of the recti muscles, in which the tendons of the muscles are released from their insertions and reattached to the eyeball in such a way as to induce a tilting of the vertical meridian of the eye without either lengthening or shortening the muscle and without injuring in any way the rotating ability of the muscles.

He also stated that nearly all his cases of trigeminal neuralgia had been referred to him by colleagues with supposed muscular anomalies of the eyes and that he had usually found these conditions to be present.

PAPER OF THE EVENING.

Dr. H. H. JANEWAY. **The therapeutic use of radium in ophthalmology.** Based on experience at the Memorial Hospital (appears in full in this issue.)

DISCUSSION. Dr. C. EVERETT FIELD: Our first radium applications in ophthalmic practice were made at the Radium Institute five years ago. About ninety cases have been treated to date. The results, in the main, have been encouraging and I am convinced that radium therapy should be classed as an essential adjunct.

Radium often prepares the way for operation and where the knife is elected, we may hope to check metastasis by the prophylactic use of radium. The eye and adjacent tissues are powerfully resistant to radium, and there remains little danger of harmful effects. Radium offers many advantages over X-

ray. Aside from its routine use for malignant conditions threatening the eye, we have been favorably impressed with the results of radium for the treatment of vernal catarrh, corneal ulcers, and in a few cases of cataract. Our experience has been confined to the use of radium element in the form of tubes and surface applicators. We are not fully informed as to the technic of use of active deposit and hesitate to endorse the wide field active deposit applicator to be slipped under the lid for the treatment of vernal catarrh.

It is a well known fact that this condition manifests itself in patches of false membrane which should require the localized direct action of radium.

During the last four years, we have treated about twenty-five cases of vernal catarrh. Relief has occurred in all of our cases and I believe every case can be helped. A cure, however, should not be claimed until the second summer has been passed. We have had five cases of cataract and in these the application has controlled the process, improved vision, but no cure is reported.

In vernal catarrh, our treatments require the use of twenty-five milligrams of radium, applied with .5*mm* gold screen for a period of nine to twelve minutes every third week. Three radiations usually are classed as a series. Relief is afforded by the first application.

Corneal ulcers receive a dosage by direct application with a 2 milligram tube for a period of four to six minutes. Three cases during the past year, that resisted all other treatment, responded favorably to radium.

Our treatment of cataract has been of two types: The direct application of 25 milligrams just free of the surface of the eye for a period of four to nine minutes. More recently we have favored the dosage advocated by Levin, namely 25 milligrams with a distance screen of ½″ applied for one hour. Treatments as here indicated should be inaugurated by the ophthalmologist at our various hospitals receiving eye cases and should not be sent to radium institutes. Good work in ophthalmology could be accomplished with a radium applicator to cost from $600 to $1000.

Where malignancy is a part of the diagnosis, such cases should be referred at once to the cancer specialist, familiar

with radium therapy. The wide range of screenage and dosage to properly attack cancer or to exert prophylaxis requires the knowledge of an expert diagnostician, who is a deep student of pathology and physics.

Dr. ISAAC LEVIN: I enjoyed listening to Dr. Janeway's excellent presentation of his pioneer work at the Memorial Hospital.

The general technic of radium-therapy on cancer is very similar, whatever the organ involved. Nevertheless, the eyeball differs from all other organs, on account of its size and anatomical construction, and it presents the most simple organ in the body to treat with radium. Radium-therapy is applied in two ways: superficial and deep. In the deep, the rays pass through a layer of normal tissues before they reach the diseased part. In the superficial, the application is made directly on to the diseased surface. While the latter method, with comparatively soft rays and little filtration, may be used in the treatment of conditions like corneal ulcers, generally speaking, methods of deeper therapy should be employed in all diseases of the eye.

In vernal catarrh, in my opinion, the ultimate result is not very satisfactory, since notwithstanding the temporary disappearance of the conjunctival abnormalities, the process continues in its course. I have had six cases of vernal catarrh, which were all improved. I fear, however, that the condition recurred subsequently in all the cases treated.

As to the results in cataracts, I do not know yet whether permanent therapeutic results were obtained, but some distinct biologic influence was exerted on a sufficiently large number of cases to make it worth while to continue the work. We have proven that with the hard, deep, penetrating, well filtered rays used in proper quantity, no injury can be done to the normal structures of the eye. I have repeatedly placed large quantities of radium directly over the orbit, leaving them in place for twenty hours at a stretch, without causing any damage to the eye. As I stated above, radium application to the eye is simple, and comparatively small quantities are required. Every ophthalmologist can learn easily to apply this method of treatment. It is well worth while to test it for a few years and thus obtain a correct estimation of its value.

Dr. JOHN E. WEEKS: I will briefly refer to a few of the cases that Dr. Janeway has treated at my suggestion. The first was a case of double glioma of the retina. One eye was removed. In the remaining eye, the tumor was not large, measuring between two and three disk diameters. After the first two applications of radium, the growth seemed to be retarded; then however it went on advancing, notwithstanding five additional applications. The patient died two weeks ago, after having been under observation for two years.

I have had the privilege of looking at the case reported by Dr. Schoenberg on two occasions. It seems to me that there has been a recession of the growth, an apparent arrest and shrinkage.

As to vernal catarrh, my experience is limited to one case in which the symptoms improved, but recurred the summer after. In the case presented here this evening, although the conjunctiva is quite smooth, the disease is not cured by any means. The results in two other cases which I have seen were very gratifying, but they had not completely recovered.

In regard to cataract, as the condition is due to a degeneration of the lens tissue, I do not see how cataract can be dissipated by the use of radium. If the nutrition of the lens can be increased, it may be possible to clear up some of the haziness due to the presence of turbid fluids, but we cannot restore degenerated lens fibers by the use of any agent.

In two cases of epithelioma of the ocular conjunctiva in which recurrences had taken place after excision, apparent cures were effected by the use of radium. In two cases of epithelioma of the eyelids radium was most efficient. In no case have I seen injury to the globe as a result of the use of either radium or the X-ray.

Dr. M. J. SCHOENBERG: I deem this an opportune moment to relate my experiences concerning some ophthalmological complications arising as a result of radium-therapy.

Burns of the lids, bulbar conjunctiva, and cornea, also loss of lashes and lenticular opacities have come under my observation following the applications of radium as a therapeutic measure.

The burn of the bulbar conjunctiva presented the appearance of a thick, white, glossy porcelain-looking patch upon a

patient treated with radium for vernal catarrh. This same patch remained unchanged for nearly one year. Two other patients treated likewise presented corneal burns of both eyes, consisting of numerous foci of denuded superficial epithelium causing the patient considerable annoyance (photophobia, lacrimation, and pain) over a period exceeding three months.

Concerning the lenticular opacities—they appeared in my little patient with glioma of the retina following a few radium applications. Axenfeld has seen a similar case. Whether these opacities of the lens are due to the intraocular disturbance or really caused by the radium-therapy, we are not as yet prepared to say. However it is reasonable to believe that the lens of a child is unable to withstand radium-therapy with the same impunity as the adult.

In my second patient with glioma of the retina I wish to emphasize the fact that there were no chorioretinal changes, whereas in my first case of glioma there developed a ring of chorioretinitis surrounding the gliomatous mass; these findings may suggest an explanation for the radium acting favorably in one case and not at all in the other. There is a possibility of the area of chorioretinitis developed during the course of treatment having acted as a barrier to the extension and further spreading of the new growth.

Dr. KNAPP: There is one point which I think Dr. Janeway has not sufficiently emphasized. I believe it is his firm opinion that the efficacy of radium depends upon the administration of a single large dose. I hope Dr. Janeway will enlarge upon this. I should also like to ask him whether the eye cannot be regarded as being unusually tolerant.

Dr. JANEWAY: It is very important to use a single large dose in the treatment of malignant tumors. Success in the treatment of cancer depends greatly on the adjustment of the dose to the lesion in a way which will produce the maximum effect in one sitting. In doing this, injury to the normal tissues must be avoided and in our experience can be avoided in applying a single large dose. I feel that the eye is responsive and at the same time tolerant to radium. Injuries such as possibly development of cataract are not yet well understood. The retina is surely a tissue which is susceptible to these radiations, possibly more so than we believe.

I am glad that Dr. Weeks called attention to the fact that we should not classify cases of vernal catarrh as cures. At the same time, I am very firmly impressed with the improvements which have occurred in our cases. Bad complications such as burns are inexcusable. They are due to faulty technic which is only justified in the earliest days of a new method of treatment.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM.

PRESIDENT: J. B. STORY, P.R.C.S.I.

ANNUAL CONGRESS, 1920

The next Annual Congress of the Society will be held on Thursday, Friday, and Saturday, 29th and 30th of April and 1st of May, 1920.

The arrangements will be as follows:

THURSDAY, APRIL 29th.

MORNING.	**At the Royal Society of Medicine, 1, Wimpole Street, W. 1.**
10 A.M. to 12.30 P.M. ...	**President's Opening Address.** Papers.
AFTERNOON.	**At the Royal London Ophthalmic Hospital, City Road, E.C. 1.**
3 P.M.	Clinical Meeting. Exhibit of books, museum specimens, drawings and portraits belonging to the Hospital. Members will dine together in the evening.

FRIDAY, APRIL 30th.

At the Royal Society of Medicine, 1, Wimpole Street, W. 1.

10 A.M. ... ... Discussion on "Diabetes in Relation to Diseases of the Eye." To be opened by Sir ARCHIBALD GARROD, Mr. R. FOSTER MOORE, and Dr. E. SPRIGGS. The following also intend to speak: Dr. LEYTON, Mr. G. MACKAY, Dr. POYNTON, Mr. P. H. ADAMS, Dr. CAMMIDGE, Mr. GRAY CLEGG, and Dr. A. RENSHAW.

5.30 P.M. ... ... Business Meeting.

8.30 P.M. ... ... Papers.

SATURDAY, MAY 1st.

10 A.M. ... ... **Visit to St. Margaret's Hospital, Leighton Road, N. W. 5, the Special Hospital of the Metropolitan Asylums Board for cases of Ophthalmia Neonatorum.**

Discussion on "The Prevention and Treatment of Ophthalmia Neonatorum." To be opened by Dr. GIBBON FITZGIBBON, Master of the Rotunda Hospital, and Mr. M. S. MAYOU. The following intend to speak: Mrs. SCHARLIEB, Dr. MACRORY, Messrs. SYDNEY STEPHENSON, MAITLAND RAMSAY, and J. WHARTON.

Members desirous of reading Papers, showing Cases, or taking part in the Discussions, are requested to communicate as soon as possible with Mr. F. A. JULER, 24, Cavendish Square, London, W. 1.

Papers and Communications, subject to the judgment of the Council, will be printed in full in the "Transactions."

Under the By-laws readers of Papers must not exceed twenty minutes, subsequent speakers ten minutes. The openers of the Discussions are allowed twenty minutes.

All Communications must be typewritten.

R. R. JAMES
F. A. JULER } *Hon. Secs.*